DEPARTMENT OF THE ARMY TECHNICAL MANUAL TM 11-2684

DEPARTMENT OF THE AIR FORCE TECHNICAL ORDER TO 16-35TS312-15

AUDIO OSCILLATORS TS–312/FSM–1 AND TS–382/U

DEPARTMENTS OF THE ARMY AND THE AIR FORCE

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AUDIO OSCILLATORS TS–312/FSM–1 AND TS–382/U

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CONTENTS

Paragraphs — *Page*

CHAPTER 1. INTRODUCTION

Section I. General — 1, 2 — 1
II. Description and data — 3–7 — 1

CHAPTER 2. OPERATING INSTRUCTIONS

Section I. Service upon receipt of equipment — 8–11 — 4
II. Controls and instruments — 12, 13 — 6
III. Operation under usual conditions — 14–16 — 7
IV. Operation under unusual conditions. — 17–20 — 7

CHAPTER 3. ORGANIZATIONAL MAINTENANCE INSTRUCTIONS

Section I. Preventive maintenance services — 21–24 — 9
II. Lubrication and weatherproofing — 25–27 — 10
III. Trouble shooting at organizational maintenance level — 28–31 — 11
CHAPTER 4. THEORY — 32–35 — 13

5. FIELD MAINTENANCE INSTRUCTIONS

Section I. Trouble shooting at field maintenance level — 36–40 — 18
II. Repairs — 41, 42 — 23
III. Calibration — 43–47 — 23
IV. Final testing — 48–51 — 24

CHAPTER 6. SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

Section I. Shipment and limited storage — 52, 53 — 25
II. Demolition of matériel to prevent enemy use — 54–55 — 25
APPENDIX I. REFERENCES — ----- — 26
II. IDENTIFICATION TABLE OF PARTS — ----- — 28
INDEX — ----- — 33

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WARNING

HIGH VOLTAGE

is used in the operation of
this equipment.

DEATH ON CONTACT

may result if operating personnel
fail to observe safety precautions.

First Aid for Electric Shock

RESCUE.

In case of electric shock, shut off the high voltage at once and ground the circuits. If the high voltage cannot be turned off without delay, free the victim from contact with the live conductor as promptly as possible. Avoid direct contact with either the live conductor or the victim's body. Use a dry board, dry clothing, or other nonconductor to free the victim. An ax may be used to cut the high-voltage wire. Use extreme caution to avoid the resulting electric flash.

SYMPTOMS.

a. Breathing stops abruptly in electric shock if the current passes through the breathing center at the base of the brain. If the shock has not been too severe, the breath center recovers after a while and normal breathing is resumed, provided that a sufficient supply of air has been furnished meanwhile by artificial respiration.

b. The victim is usually very white or blue. The pulse is very weak or entirely absent and unconsciousness is complete. Burns are usually present. The victim's body may become rigid or stiff in a very few minutes. This condition is due to the action of electricity and is not to be considered rigor mortis. Artificial respiration must still be given, as several such cases are reported to have recovered. The ordinary and general tests for death should never be accepted.

TREATMENT.

a. Start artificial respiration immediately. At the same time send for a medical officer, if assistance is available. Do not leave the victim unattended. Perform artificial respiration at the scene of the accident, unless the victim's or operator's life is endangered from such action. *In this case only,* remove the victim to another location, but no farther than is necessary for safety. If the new location is more than a few feet away, artificial respiration should be given while the victim is being moved. If the method of transportation prohibits the use of the Shaeffer prone pressure method, other methods of resuscitation may be used. Pressure may be exerted on the front of the victim's diaphragm, or the direct mouth-to-mouth method may be used. Artificial respiration, once started, must be continued, without loss of rhythm.

b. Lay the victim in a prone position, one arm extended directly overhead, and the other arm bent at the elbow so that the back of the hand supports the head. The face should be turned away from the bent elbow so that the nose and mouth are free for breathing.

c. Open the victim's mouth and remove any foreign bodies, such as false teeth, chewing gum, or tobacco. The mouth should remain open, with the tongue extended. Do not permit the victim to draw his tongue back into his mouth or throat.

d. If an assistant is available during resuscitation, he should loosen any tight clothing to permit free circulation of blood and to prevent restriction of breathing. He should see that the victim is kept warm, by applying blankets or other covering, or by applying hot rocks or bricks wrapped in cloth or paper to prevent injury to the victim. The assistant should also be ever watchful to see that the victim does not swallow his tongue. He should continually wipe from the victim's mouth any frothy mucus or saliva that may collect and interfere with respiration.

e. The resuscitating operator should straddle the victim's thighs, or one leg, in such manner that:

(*1*) the operator's arms and thighs will be vertical while applying pressure on the small of the victim's back;

(*2*) the operator's fingers are in a natural position on the victim's back with the little finger lying on the last rib;

(*3*) the heels of the hands rest on either side of the spine as far apart as convenient without allowing the hands to slip off the victim;

(*4*) the operator's elbows are straight and locked.

f. The resuscitation procedure is as follows:

(*1*) Exert downward pressure, not exceeding 60 pounds, for 1 second.

(*2*) Swing back, suddenly releasing pressure, and sit up on the heels.

(*3*) After 2 seconds rest, swing forward again, positioning the hands exactly as before, and apply pressure for another second.

g. The forward swing, positioning of the hands, and the downward pressure should be accomplished in one continuous motion, which requires 1 second. The release and backward swing require 1 second. The addition of the 2-second rest makes a total of 4

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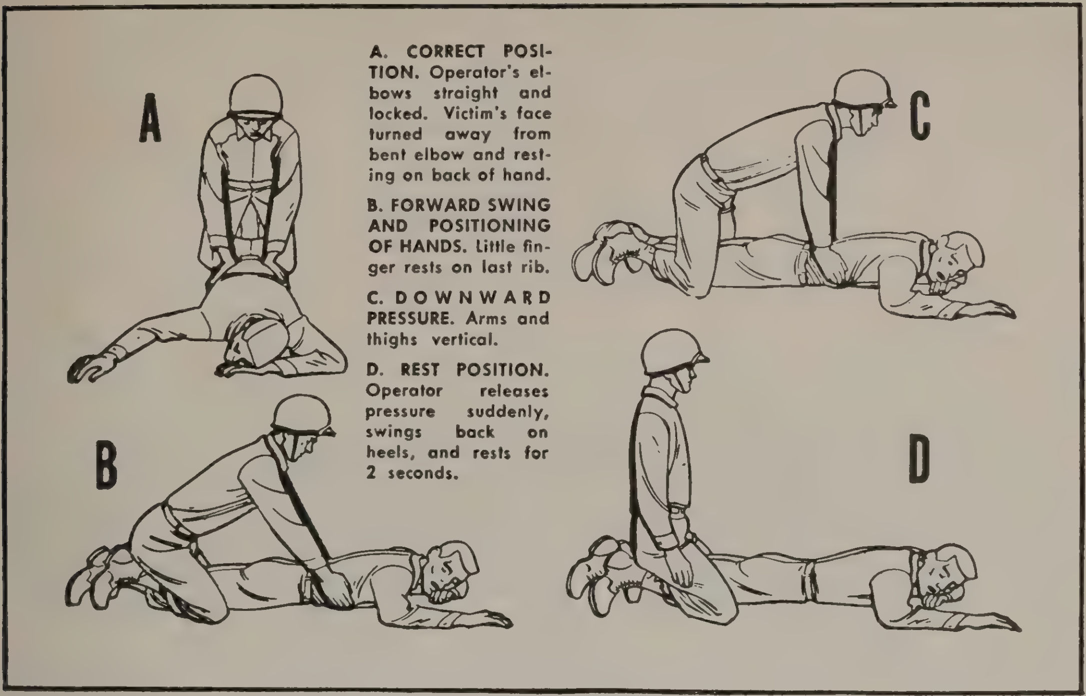

A. CORRECT POSITION. Operator's elbows straight and locked. Victim's face turned away from bent elbow and resting on back of hand.

B. FORWARD SWING AND POSITIONING OF HANDS. Little finger rests on last rib.

C. DOWNWARD PRESSURE. Arms and thighs vertical.

D. REST POSITION. Operator releases pressure suddenly, swings back on heels, and rests for 2 seconds.

seconds for a complete cycle. Until the operator is thoroughly familiar with the correct cadence of the cycle, he should count the seconds aloud, speaking distinctly and counting evenly in thousands. Example: one thousand and one, one thousand and two, etc.

h. Artificial respiration should be continued until the victim regains normal breathing or is pronounced dead by a medical officer. Since it may be necessary to continue resuscitation for several hours, relief operators should be used if available.

RELIEVING OPERATOR.

The relief operator kneels beside the operator and follows him through several complete cycles. When the relief operator is sure he has the correct rhythm, he places his hands on the operator's hands without applying pressure. This indicates that he is ready to take over. On the backward swing, the operator moves and the relief operator takes his position. The relieved operator follows through several complete cycles to be sure that the new operator has the correct rhythm. He remains alert to take over instantly if the new operator falters or hesitates on the cycle.

STIMULANTS.

a. If an inhalant stimulant is used, such as aromatic spirits of ammonia, the individual administering the stimulant should first test it himself to see how close he can hold the inhalant to his own nostril for comfortable breathing. Be sure that the inhalant is not held any closer to the victim's nostrils, and then for only 1 or 2 seconds every minute.

b. After the victim has regained consciousness, he may be given hot coffee, hot tea, or a glass of water containing ½ teaspoon of aromatic spirits of ammonia. *Do not give any liquids to an unconscious victim.*

CAUTIONS.

a. After the victim revives, keep him LYING QUIETLY. Any injury a person may have received may cause a condition of shock. Shock is present if the victim is pale and has a cold sweat, his pulse is weak and rapid, and his breathing is short and gasping.

b. keep the victim lying flat on his back, with his head lower than the rest of his body and his hips elevated. Be sure that there is no tight clothing to restrict the free circulation of blood or hinder natural breathing. Keep him warm and quiet.

c. A resuscitated victim must be watched carefully as he may suddenly stop breathing. *Never leave a resuscitated person alone until it is CERTAIN that he is fully conscious and breathing normally.*

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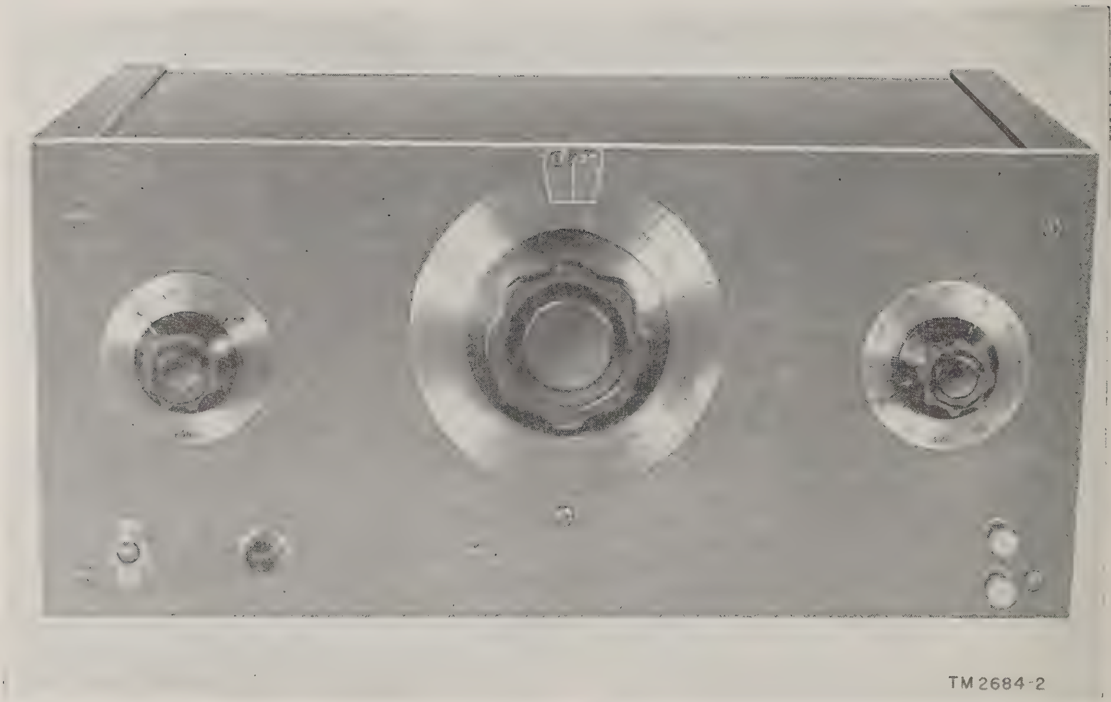


Figure 1. Audio Oscillator TS–382/U.

This manual supersedes TM 11–2684, 6 June 1945.

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

This technical manual contains instructions for the installation, operation, theory, maintenance, and repair of Audio Oscillators TS–312/FSM–1 and TS–382/U. Two appendixes cover a list of references and an identification table of parts. Since both equipments are very much alike, the word *set* or *equipment* will be used throughout the book to denote either unit.

2. Forms and Records

The following forms will be used for reporting unsatisfactory conditions of Army matériel and equipment.

a. DD Form 6, Report of Damaged or Improper Shipment, will be filled out and forwarded as prescribed in SR 745–45–5 (Army) and AFR 71–4 (Air Force).

b. DA Form 468, Unsatisfactory Equipment Report, will be filled out and forwarded to the Office of the Chief Signal Officer as prescribed in SR 700–45–5.

c. AF Form 54, Unsatisfactory Report, will be filled out and forwarded to Commanding General, Air Matériel Command, Wright-Patterson Air Force Base, Dayton, Ohio, as prescribed in SR 700–45–5 and AFR 65–26.

d. DA AGO Form 11–238, Operator First Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar), will be prepared in accordance with instructions on the back of the form.

e. DA AGO Form 11–239, Second and Third Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar), will be prepared in accordance with instructions on the back of the form.

f. Use other forms and records as authorized.

Section II. DESCRIPTION AND DATA

3. Purpose and Use

Audio Oscillators TS–382/U and TS–312/FSM–1 are used wherever a low-power test signal, ranging between 20 and 200,000 cps (cycles per second) is needed. Specifically, the equipment is useful for the following:

a. Voltage gain tests in wide band audio amplifiers.

b. Obtaining distortion and frequency response curves in wide band audio amplifiers.

c. Modulating r-f (radio-frequency) oscillators.

d. Checking equipment operating at supersonic frequencies, such as radar trainers.

4. Technical Characteristics

Frequency range	20 to 200,000 cps.
Calibration of tuning dial	20 to 200.

Bands:	
X1	20 to 200 cps.
X10	200 to 2,000 cps.
X100	2,000 to 20,000 cps.
X1000	20,000 to 200,000 cps.
Output impedance	1,000 ohms (grounded).
Frequency response	Flat within ±1 db (decibel) from 20 cps to 150,000 cps (reference voltage (0 db) = 10 volts into 1,000-ohm load measured at 400 cycles).
Frequency stability	Within ±2% under normal temperature conditions.
Distortion (rated output)	Less than 1% from 20 to 20,000 cps.
Hum	60 db below rated output.
Power input	110 to 120 volts, 60 cycles, 68 watts.
Power output	100 mw (milliwatts) into 1,000-ohm load.
Fuse rating	1 ampere.
Number of tubes	5.

5. Packaging Data

Audio Oscillator TS–382/U is 15¾ inches by 10⅝ inches by 7 inches, giving it a total volume of .67 cubic foot. The dimensions of Audio Oscillator TS–312/FSM–1 are similar, except for the protruding panel which is 19 inches by 7 inches. When either oscillator is packaged for export shipment, it is placed in a moisture-vaporproof container (fig. 3). The size, weight, and volume of the container are indicated below:

Height	12 inches.
Depth	15 inches.
Length	21 inches.
Volume	2.48 cubic feet.
Weight	63 pounds.

The equipment, fully packed for export shipment, weighs approximately 125 pounds.

6. Description

The output frequency of the oscillator is determined by the tuning dial in the center of the panel and the RANGE switch on the left-hand side. The dial is calibrated from 20 to 200, but this setting must be multiplied by the factor determined by the RANGE switch (X1, X10, X100, or X1000) to obtain the actual frequency. The amplitude of the output may be varied by the calibrated VOL control on the right side of the panel. An ON-OFF switch, pilot lamp, and a pair of binding posts are also provided. Louvers in the back of the cover supply necessary ventilation.

7. Differences in Models

Audio Oscillators TS–382/U and TS–312/FSM–1 are similar electrically. They have different nomenclature because the former is portable, whereas the latter may be rack-mounted as a component of Frequency Measuring Assembly CY–93/FSM–1. Specifically, Audio Oscillator TS–312/FSM–1 differs from Audio Oscillator TS–382/U as follows:

a. The panel is longer and it has four rack-mounting holes at the ends.

b. A hole and associated grommet are provided in the front panel to the right of the binding posts. A shielded lead from the oscillator binding posts (the center conductor is connected to the upper binding post and the shield to the bottom post) goes through this hole for connection to Switching Panel SA–30/FSM–1 for Frequency Measuring Assembly CY–93/FSM–1.

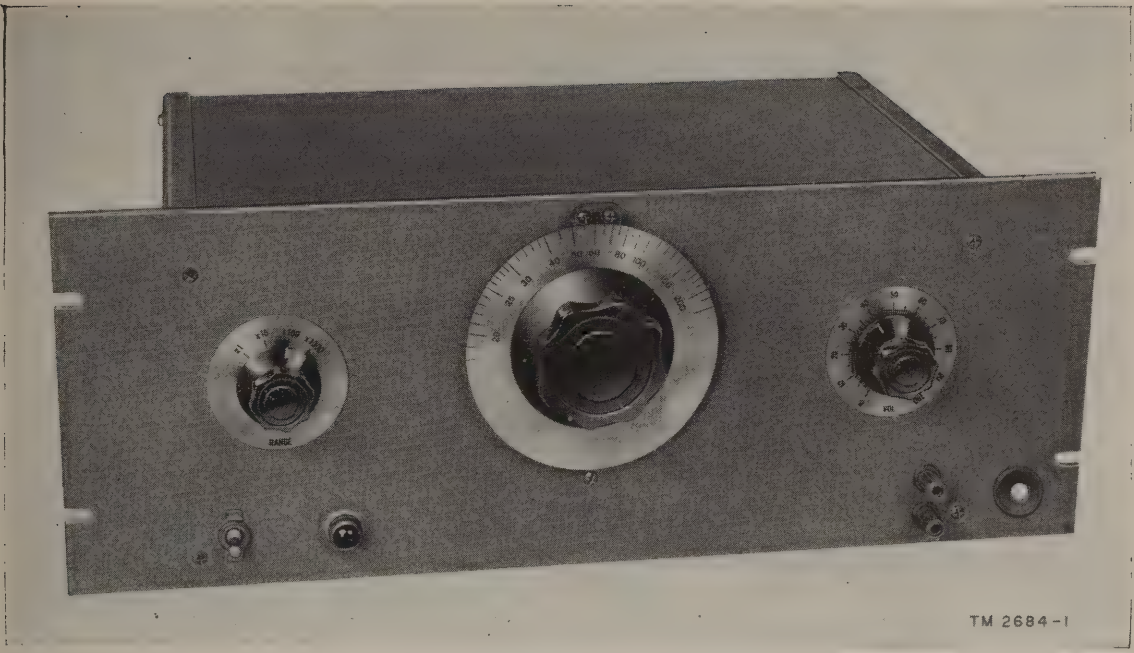


Figure 2. Audio Oscillator TS–312/FSM–1.

CHAPTER 2

OPERATING INSTRUCTIONS

Section I. SERVICE UPON RECEIPT OF EQUIPMENT

8. Uncrating, Unpacking, and Checking New Equipment

Note. For used or reconditioned equipment, refer to paragraph 11.

a. General. Equipment may be shipped in export packing cases (*b* below) or in domestic packing cases (*f* below). When new equipment is received, select a location where the equipment may be unpacked without exposure to the elements, and which is convenient to the permanent or semipermanent installation of the equipment. Aside from checking to make sure that the equipment is undamaged, no special unpacking and uncrating procedures are necessary.

Caution: Be careful in uncrating, unpacking, and handling the equipment; it is easily damaged. If it becomes damaged or exposed, a complete overhaul might be required or the equipment might be rendered useless.

b. Step-by-Step Instructions for Uncrating and Unpacking Export Shipments.

(1) Place the packing case as near the operating position as convenient.

(2) Cut and fold back the steel straps.

(3) Remove the nails with a nail puller. Remove the top and one side of the packing case. Do not attempt to pry off the sides and top; the equipment may become damaged.

(4) Remove the waterproof container or moistureproof barrier and any excelsior or corrugated paper covering the equipment inside the case. See *d* below for instructions on removing the waterproof metal container.

(5) Remove the equipment from its inner case and place it on a workbench or near its final location.

(6) Inspect the equipment for possible damage incurred during shipment.

(7) Check the contents of the packing case against the master packing slip.

c. Opening Cardboard Carton and Waterproof Barrier. No special instructions are need for opening the waterproof paper barrier and removing the equipment from the cardboard carton.

d. Instructions for Opening Metal Containers. The top of the metal container is soldered to the sides. To open, break the soldered seam by prying the side of the container away from the soldered seam as follows:

(1) Wipe off the excess solder with a soldering iron. Never use a torch because the contents of the container are inflammable.

(2) Pry the sides from the soldered seam with a wooden block or a screw driver.

(3) After completely opening the seam, pry off the cover.

(4) Remove the bags of desiccant and the protective cardboard packing and lift or draw out the packages within.

e. Checking. Check the contents against the master packing slip.

f. Unpacking Domestic Packing Cases. Radio equipment may be received in domestic packing cases. The instructions given in *b* above apply also to unpacking domestic shipments. Cut the metal bands. Open the cartons that protect the equipment, or, if heavy wrapping paper has been used, remove it carefully and take out the components. Check the con-

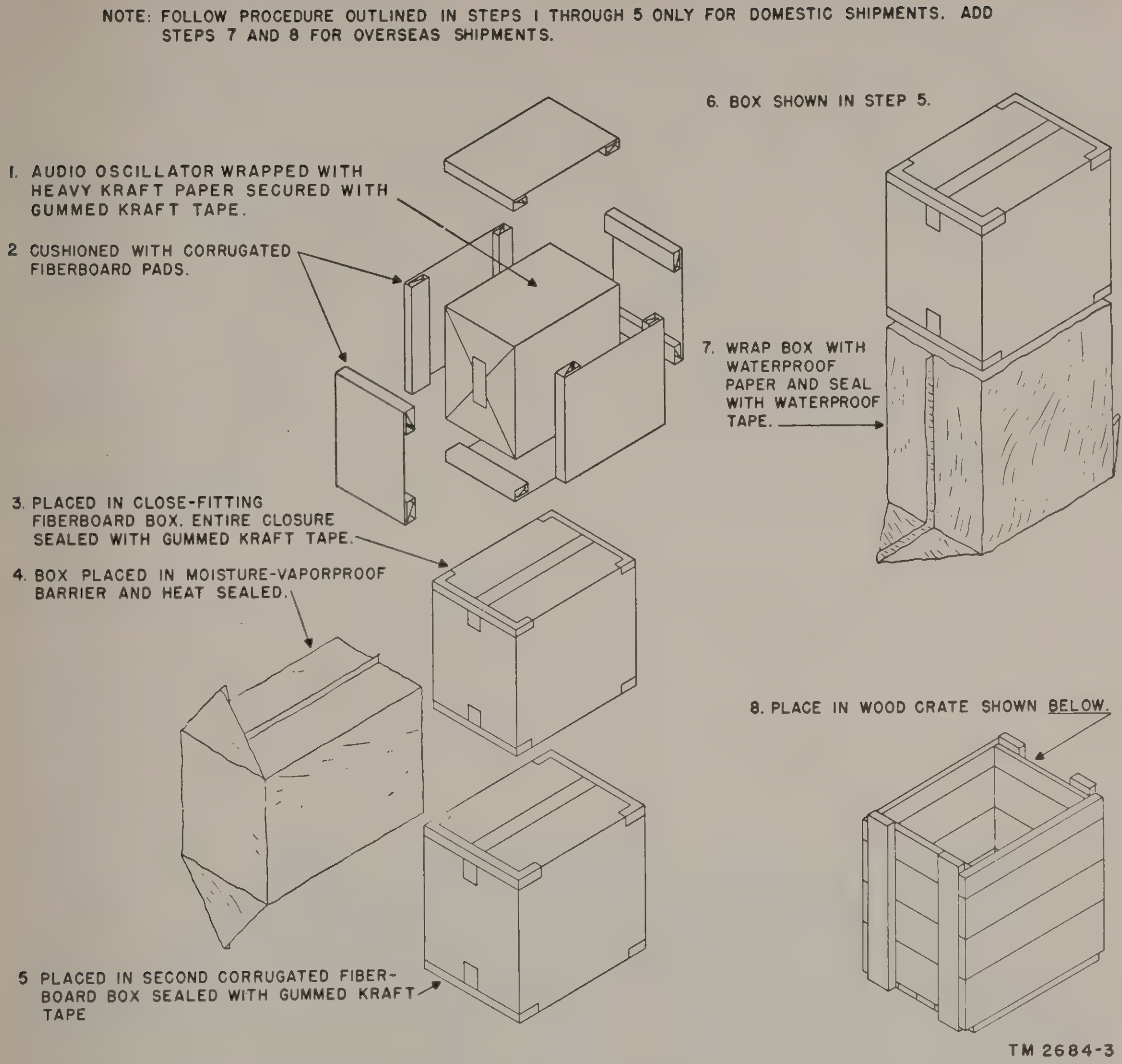

NOTE: FOLLOW PROCEDURE OUTLINED IN STEPS 1 THROUGH 5 ONLY FOR DOMESTIC SHIPMENTS. ADD STEPS 7 AND 8 FOR OVERSEAS SHIPMENTS.
1. AUDIO OSCILLATOR WRAPPED WITH HEAVY KRAFT PAPER SECURED WITH GUMMED KRAFT TAPE.
2 CUSHIONED WITH CORRUGATED FIBERBOARD PADS.
3. PLACED IN CLOSE-FITTING FIBERBOARD BOX. ENTIRE CLOSURE SEALED WITH GUMMED KRAFT TAPE.
4. BOX PLACED IN MOISTURE-VAPORPROOF BARRIER AND HEAT SEALED.
5 PLACED IN SECOND CORRUGATED FIBERBOARD BOX SEALED WITH GUMMED KRAFT TAPE
6. BOX SHOWN IN STEP 5.
7. WRAP BOX WITH WATERPROOF PAPER AND SEAL WITH WATERPROOF TAPE.
8. PLACE IN WOOD CRATE SHOWN BELOW.
TM 2684-3

Figure 3. Audio Oscillators TS–382/U and TS–312/FSM–1, packaging diagram.

tents of the packing case against the master packing slip.

Note. Save the original packing cases and containers for both export and domestic shipments. They can be used again when the equipment is repacked for storage or shipment.

9. Siting

Place the oscillator within 6 feet of the external power source and as close as possible to the equipment to be tested. The case dimensions of the oscillator (par. 5) are an indication of the space required for installing the equipment in its operating position.

10. Installation of Equipment

The following is a listing of the steps to be followed in the installation of the equipment:

a. Check the contents of the packing case against the master packing slip.

b. Thoroughly inspect the exterior of the audio oscillator for possible damage incurred during shipment.

c. Loosen the two screws on the top of both sides of the set. Remove the four Phillips-head screws in the back of the set and slide the L-shaped top cover out. Remove the two Phillips-head screws on the bottom of both sides of the set and remove the bottom cover.

d. Make certain that no vacuum tubes are broken and that they are properly seated in their sockets.

e. Inspect the wiring to make certain the lugs are securely fastened to the leads and that the leads are securely fastened to points of contact.

f. Inspect the subassembly parts to make certain they are securely fastened in place.

g. Inspect the power cord for kinks and cracks, and make certain the male contact plug is properly connected.

h. See that fuse F1 (fig. 13) is installed, and that it is 1 ampere in size.

i. Replace bottom cover and also L-shaped top cover. Tighten all screws.

Caution: The chassis of the audio oscillator has been moistureproofed and fungiproofed. *Do not remove any of the protective coating.*

11. Service upon Receipt of Used or Reconditioned Equipment

a. Follow the instructions in paragraph 8 for uncrating, unpacking, and checking the equipment.

b. Check the used or reconditioned equipment for tags or other indications pertaining to changes in the wiring of the equipment. If any changes in wiring have been made, note the change in this manual, preferably on the schematic diagram.

Section II. CONTROLS AND INSTRUMENTS

12. General

Haphazard operation or improper setting of the controls can cause damage to electronic equipment. For this reason it is important to know the function of every control. The actual operation of the equipment is discussed in paragraphs 14 through 16.

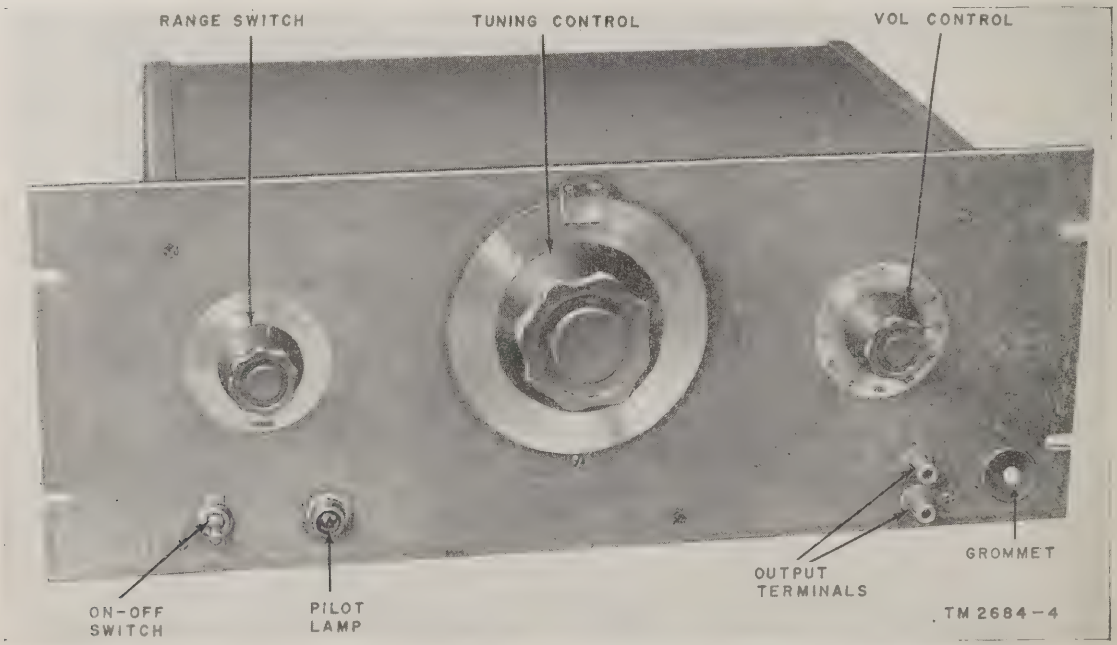


Figure 4. Audio Oscillator TS–312/FSM–1, controls.

13. Controls

The following table lists the controls of the audio oscillator and indicates their functions.

Control	Function
ON-OFF switch	In ON position, connects a-c (alternating current) power source.
Pilot lamp	Indicates when a-c power is on.
RANGE switch	Determines frequency range.
Tuning control	Together with RANGE switch, determines actual output frequency.
VOL. control	Varies amplitude of output frequency.
Output terminals	Output obtained from across these terminals.

Note. Controls and their function are the same for Audio Oscillator TS–312/FSM–1 and Audio Oscillator TS–382/U.

Section III. OPERATION UNDER USUAL CONDITIONS

14. Preliminary Starting Procedure

a. Plug the line cord into a 115-volt a-c outlet. Connect a shielded lead from the binding posts of the oscillator to the input of the equipment under test. Make sure that the center conductor is attached to the upper binding post, and that the shield is attached to the lower binding post.

b. The VOL. control is not accurately calibrated. For tests requiring accuracy, a vtvm (vacuum-tube voltmeter) may be placed across the oscillator output. Where small output voltages are required, the use of an attenuator between the oscillator and the equipment under test is desirable.

15. Starting Procedure

a. Set the ON-OFF switch to ON and allow the equipment to warm up for 10 or 15 minutes. The pilot lamp should be lit when the set is in operation.

b. Set the RANGE switch to the band containing the frequency or frequencies wanted. The four bands and the frequencies which they cover are as follows:

Band	*Frequency range*
X1	20 to 200 cps
X10	200 to 2,000 cps
X100	2,000 to 20,000 cps
X1000	20,000 to 200,000 cps

c. Turn the tuning dial so that the hairline is at the point where the dial reading multiplied by the multiplication factor gives the frequency wanted.

(1) For example, to obtain an output frequency of 350 cps, proceed as follows: Since 350 cps lies between 200 and 2,000 cps, it is in the X10 band. Place RANGE switch on X10. Then turn the tuning dial so that 35 is under the hairline. The oscillator is now tuned to 350 cps. As a check, note that 350 is obtained when 35 is multiplied by the factor indicated on the RANGE switch, namely, 10.

(2) To obtain an output frequency of 140,000 cps (between 20,000 and 200,000 cps), place RANGE switch on X1000. Turn tuning dial to 140. Again check the reading by noting that 140 multiplied by the factor of 1,000 equals 140,000 cps.

d. Use the VOL. control for adjusting the amplitude of the output signal.

16. Stopping Procedure

a. Set the ON-OFF switch to the OFF position.

b. Disconnect the power cord and all external connections.

Section IV. OPERATION UNDER UNUSUAL CONDITIONS

17. General

The operation of Audio Oscillators TS–382/U and TS–312/FSM–1 may be difficult in regions where extreme cold, heat, humidity and moisture, sand conditions, etc., prevail. In the paragraphs 18–20 instructions are given on procedures for minimizing the effect of these unusual operating conditions.

18. Operation in Arctic Climates

Subzero temperatures and climatic conditions associated with cold weather affect the efficient operation of the equipment. Instructions and precautions for operation under such adverse conditions follow:

a. Handle the equipment carefully.

b. Keep the equipment warm and dry. If the set is not in a heated inclosure, construct an insulated box for the equipment.

c. Locate the equipment inside a heated inclosure where there is no danger of a cold draft striking the glass tubes when a door is opened. A sudden draft of cold air is often sufficient to shatter the glass envelope of a heated tube. If the inclosure is so constructed that this precaution is impossible, place a blanket or some barrier between the source of draft and the equipment.

d. When equipment which has been exposed to the cold is brought into a warm room, it sweats, until it becomes as warm as its surroundings. This condition also arises when equipment warms up during the day after exposure during a cold night. Allow the equipment to reach room temperature. Then dry it thoroughly.

19. Operation in Tropical Climates

When operated in tropical climates, radio equipment may be installed in tents, huts, or when necessary, in underground dugouts. When equipment is installed below ground and when it is set up in swampy areas, moisture conditions are more acute than normal in the tropics. Ventilation is usually very poor, and the high relative humidity causes condensation of moisture on the equipment whenever the temperature of the equipment becomes lower than that of the ambient air. To minimize this condition, place electric bulbs under the equipment.

20. Operation in Desert Climates

a. Conditions similar to those encountered in tropical areas often prevail in desert areas. Use the same measures to insure proper operation of the equipment.

b. Never tie power cords, signal cords, or other wiring connections to either the inside or the outside of tents. Desert areas are subject to sudden wind squalls which may jerk the connections loose or break the lines.

c. Take care to keep the equipment as free as possible from dust. Make frequent preventive maintenance checks.

CHAPTER 3

ORGANIZATIONAL MAINTENANCE INSTRUCTIONS

Section I. PREVENTIVE MAINTENANCE SERVICES

21. Definition of Preventive Maintenance

Preventive maintenance is work performed on equipment (usually when the equipment is not in use) to keep it in good working order so that break-downs and needless interruptions in service will be kept to a minimum. Preventive maintenance differs from trouble shooting and repair since its object is to prevent certain troubles from occurring. See AR 750–5.

22. Tools and Materials

The following tools and materials are required for organizational maintenance.

a. Tools.

Tool Equipment TE–113, or equal.

b. Materials.

(1) Orangestick.

(2) Cheesecloth.

(3) Carbon tetrachloride.

(4) Paper, sand, flint, No. 0000.

(5) Solvent, dry-cleaning (SD) (Fed. spec No. P–S–661a).

23. General Preventive Maintenance Techniques

a. Use No. 0000 sandpaper to remove corrosion.

b. Use a clean, dry, lint-free cloth or a dry brush for cleaning.

(1) If necessary, except for electrical contacts, moisten the cloth or brush with solvent (SD); then wipe the parts dry with a cloth.

(2) Clean electrical contacts with a cloth moistened with carbon tetrachloride; then wipe them dry with a cloth.

c. If available, dry compressed air may be used at a line pressure not exceeding 60 pounds per square inch to remove dust from inaccessible places; be careful however, or mechanical damage from the air blast may result.

d. For further information on preventive maintenance techniques, refer to TB SIG 178.

24. Performing Preventive Maintenance

The following preventive maintenance operations should be performed by organizational personnel at the intervals indicated, unless these intervals are reduced by the local commander:

Caution: Screws, bolts, and nuts should not be tightened carelessly. Fittings tightened beyond the pressure for which they are designed will be damaged or broken.

a. Daily.

(1) Clean exterior of cabinet.

(2) Check operation of pilot light.

b. Weekly.

Caution: Disconnect all power before performing the following operations. Upon completion, reconnect power and check for satisfactory operation.

(1) Clean interior and exterior of chassis.

(2) Inspect tubular paper capacitors C3, C4, and C5, and tubular electrolytic capacitors C6 and C7 for blistering or other evidence of overheating.

(3) Inspect power transformer TR1 for signs of excessive heating.

(4) Inspect fuse F1 and its fuseholder for corrosion, cracks, and lack of tension sufficient to insure good contact.

c. Monthly.

Make visual inspection of the following; tighten and/or clean *if necessary*:

(1) Tube and capacitor sockets and pins, for loose contacts, dirt, and corrosion. Check vacuum tubes; replace if necessary. Note that tubes including final letters W or Y in their nomenclature can replace tubes of the same type; for example, 6J7W can replace 6J7.

(2) Terminals of filter capacitors C11 and C13, for corrosion.

(3) Resistors, for blistering, discoloration, and other evidence of overheating.

(4) Switches S1 and S2, for dirt, corrosion, loose contacts, and unsatisfactory mechanical action.

(5) Wires, cords, cables, for cracked, cut and frayed insulation.

(6) Potentiometer R16, for unsatisfactory electrical and mechanical operation.

(7) Mountings, machine screws, and nuts, for mechanical looseness.

(8) All visible terminals and connections, for loose connections and corrosion.

(9) MFP coatings, for breaks. (Retouch with a brush, if necessary.)

(10) Finish, for scratches and bare spots. (Retouch, if necessary.)

(11) Variable capacitor C2, for dirt, corrosion, and bent plates.

(12) Insulators, for cracks and dirt.

Section II. LUBRICATION AND WEATHERPROOFING

25. Lubrication

Audio Oscillator TS–382/U and Audio Oscillator TS–312/FSM–1 require no lubrication.

26. Weatherproofing

a. General. Signal Corps equipment, when operated under severe climatic conditions, such as prevail in tropical, arctic, and desert regions, requires special treatment and maintenance. Fungus growth, insects, dust, corrosion, salt spray, excessive moisture, and extreme temperatures are harmful to most materials.

b. Tropical Maintenance. A special moistureproofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection. This treatment is explained in TB SIG 13 and TB SIG 72.

c. Winter Maintenance. Special precautions necessary to prevent poor performance or total operational failure of equipment in extremely low temperatures are explained in TB SIG 66 and TB SIG 219.

d. Desert Maintenance. Special precautions necessary to prevent equipment failure in areas subject to extremely high temperatures, low humidity, and excessive sand and dust are explained in TB SIG 75.

e. Lubrication. The effects of extreme cold and heat on materials and lubricants are explained in TB SIG 69. Observe all precautions outlined in TB SIG 69.

27. Rustproofing and Painting

a. When the finish on the case has been badly scarred or damaged, touch up the bared surfaces to prevent rust and corrosion. Clean the surface down to the bare metal using No. 00 or No. 000 sandpaper; obtain a bright, smooth finish.

Caution: Do not use steel wool. Minute particles frequently enter the case and cause harmful internal shorting or grounding of circuits.

b. When a touch-up job is necessary, apply paint with a small brush. Remove rust from the case by cleaning corroded metal with solvent (SD). In severe cases it may be necessary to use solvent (SD) to soften the rust and to use sandpaper to complete the preparation for painting. Paint used should be authorized and consistent with existing regulations.

Section III. TROUBLE SHOOTING AT ORGANIZATIONAL MAINTENANCE LEVEL

28. Scope

The trouble shooting and repair work that can be performed at the organizational maintenance level (operators and repairmen) is necessarily limited in scope by the tools, test equipment, and replaceable parts issued, and by the existing tactical situation. Accordingly, trouble shooting is based on the performance of the equipment and the use of the senses in determining such troubles as burned-out resistors, cracked insulators, etc.

29. Visual Inspection

a. Failure of this equipment to operate properly will usually be caused by one or more of the following faults:

- (1) Worn, broken, or disconnected cord or plug.
- (2) Burned-out fuse.
- (3) Defective tubes.
- (4) Burned insulation and resistors.
- (5) Loose or missing screws, particularly those which fasten tube sockets in place.
- (6) Wires broken because of excessive vibration.

b. When failure is encountered and the cause is not immediately apparent, check as many of the above items as is practicable before starting a detailed examination of the component parts of the system. If possible, obtain information from the operator of the equipment regarding performance at the time the trouble occurred.

30. Trouble Shooting by Using Equipment Performance Checklist

a. General. The equipment performance checklist (par. 31) will help the operator to locate trouble in the equipment. The list gives the item to be checked, the conditions under which the item is checked, the normal indications and tolerances of correct operation, and the corrective measures the operator can take. *In using this list, perform the checks in the sequence indicated.*

b. Action or Condition. For some items, the information given in the action or condition column consists of various switch and control settings under which the item is to be checked. For other items it represents an action that must be taken to check the normal indication given in the normal indications column.

c. Normal Indications. The normal indications listed include the visible and audible signs that the operator should perceive when he checks the items. If the indications are not normal, the operator should apply the recommended corrective measures.

d. Corrective Measures. The corrective measures listed are those the operator can make without turning in the equipment for repairs. A reference in the table to chapter 5 indicates that the trouble cannot be corrected during operation and that trouble shooting by an experienced repairman is necessary. If the set is completely inoperative or if the recommended corrective measures do not yield results, trouble shooting is necessary.

31. Equipment Performance Checklist

	Item No.	Item	Action or condition	Normal indications	Corrective measures
PREPARATORY	1	Binding posts	Connect shielded lead from posts to input of equipment under test. Connect vtvm or another indicator, across binding posts.		
	2	RANGE switch	Place on X1 position.		
	3	Tuning dial	Place on 20		
	4	VOL. control	Place on zero		

	Item No.	Item	Action or condition	Normal indications	Corrective measures
EQUIPMENT PERFORMANCE	5	ON-OFF switch	Place in the ON position.	Pilot lamp lights	Check fuse F1. See if a-c plug is in the socket. Check transformer TR1.
				Vtvm across output reads zero.	Refer to chapter 5.
	6	VOL. control	Turn to end of range. Then bring it back to about 50.	Amplitude of output increases, then decreases somewhat.	See that vtvm or other indicator is connected properly. Check all tubes. Refer to chapter 5.
	7	RANGE switch	Place, in turn, on X10, X100, and X1000.	Amplitude of output should vary only slightly.	Check RANGE switch S1 contacts. Refer to chapter 5.
	8	Tuning dial	Turn across entire scale.	Amplitude of output should not vary much except for frequencies above 150,000 cps.	Check all tubes. Refer to chapter 5.
STOP	9	ON-OFF switch	Turn to OFF position.	Pilot light goes out.	

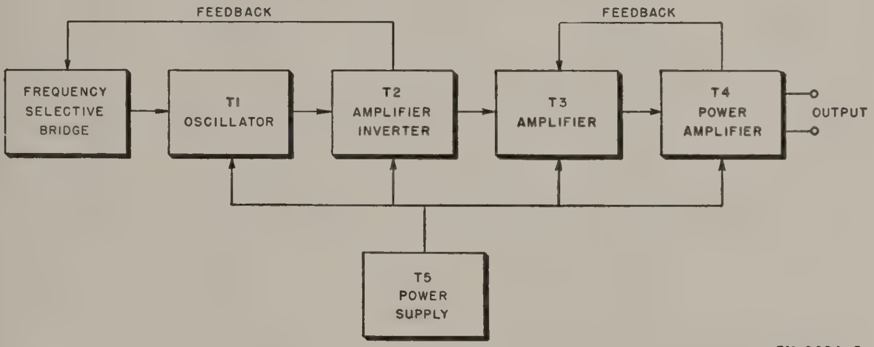
CHAPTER 4

THEORY

32. Block Diagram

(fig. 5)

The equipment consists of a Wien-bridge oscillator whose output is fed through a volume control to a two-stage resistance-capacitance coupled amplifier. The block diagram indicates stage relationship and also the main feedback paths. A complete schematic diagram is shown in figure 17.



TM 2684-5

Figure 5. Audio Oscillators TS–382/U and TS–312/FSM–1, block diagram.

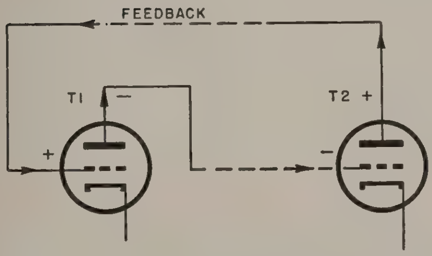


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Figure 6. Fundamental feedback diagram.

33. Wien-bridge Oscillator

A simplified schematic of the Wien-bridge oscillator circuit with the RANGE switch set for *X*10 is shown in figure 8. In order to understand its operation clearly, consider the outline schematics of figures 6 and 7. In figure 6, suppose a positive-going signal is applied to the grid of tube *T*1. Because of the 180° inversion caused by each amplifier, the output of tube *T*2 is also positive going. If this signal is fed back to the grid of tube *T*1, it arrives in phase and reinforces the original signal. This positive feedback produces oscillations.

a. Positive and Negative Feedback. The main drawback of this oscillator is that it can oscillate at any frequency. To make the circuit frequency selective, a bridge is placed in the feedback path, as shown in figure 7. The bridge splits the feedback path: positive feedback through *R*2 and *C*2*A* to the grid, negative feedback through *R*9 and *R*10 to the cathode. Oscillations can occur at only the one frequency where the amplitude of the positive feedback voltage to tube *T*1 exceeds the amplitude of the negative feedback.

(1) *Negative feedback.* Figure 8 shows how negative feedback is produced. A

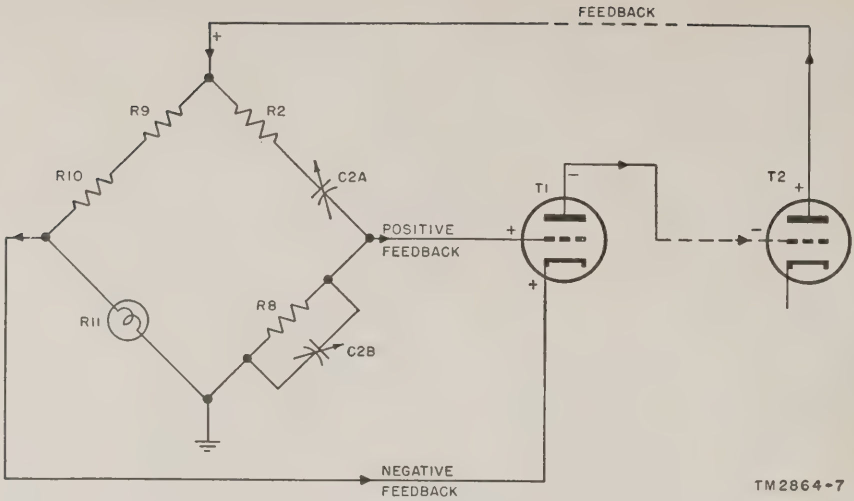


Figure 7. Using a bridge to obtain positive and negative feedback.

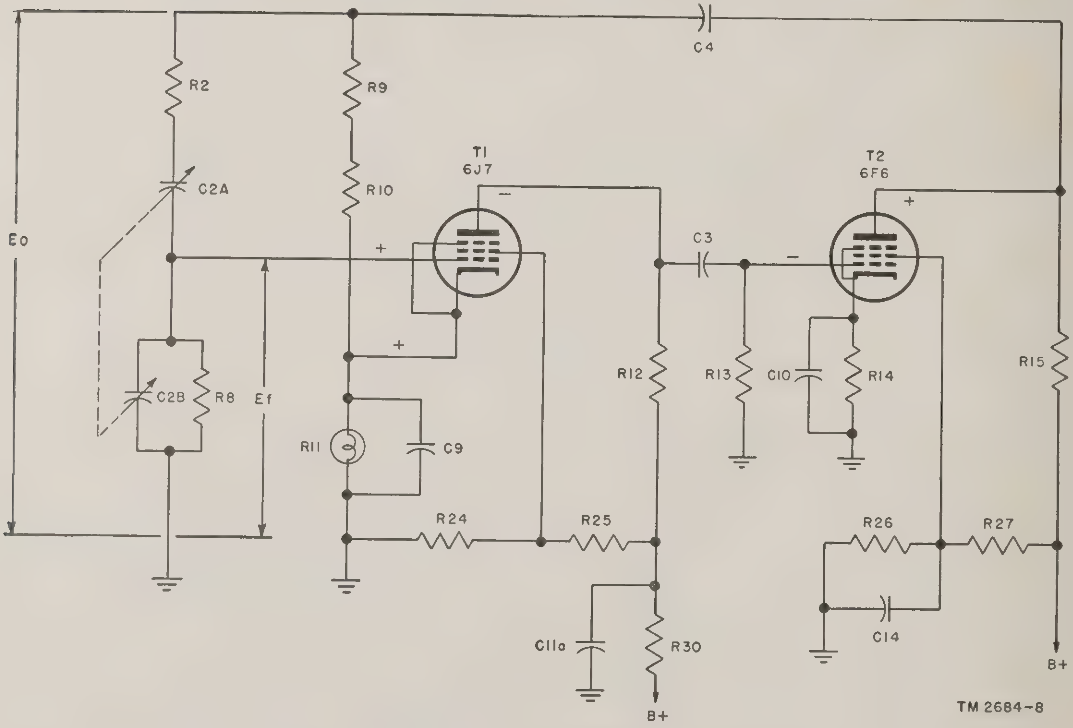


Figure 8. Wien-bridge oscillator, simplified schematic diagram.

positive-going signal on the grid of tube *T*1, after being inverted by tubes *T*1 and *T*2, results in a positive-going signal across the voltage divider, consisting of resistors *R*9 and *R*10, and lamp *R*11. That part of the voltage developed across lamp *R*11, when applied to the cathode of tube *T*1, tends to counteract the effect of the original signal on the grid. This is so, because a positive-going signal on the *cathode* tends to *decrease* the plate current flow, while the same signal on the *grid* tends to *increase* the plate current flow. Since the voltage divider consists of resistors only, the amplitude of the negative feedback does not vary with the frequency.

(2) *Positive feedback.* The positive feedback voltage is provided by the voltage divider consisting of *R*2, *C*2*A*, and *R*8 and *C*2*B*. A positive-going signal on the grid of tube *T*1, after completing the feedback path, returns to the grid as a positive-going signal, or in phase. At high frequencies the reactance of capacitors *C*2*A* and *C*2*B* is close to zero. Since resistor *R*8 is shunted by a very low reactance, the voltage between the grid of *T*1 and ground is almost zero, and very little positive feedback is produced. On the other hand, at very low frequencies the reactances of capacitors *C*2*A* and *C*2*B* become very great. The increased reactance of *C*2*A* reduces the current flow through it to a minute amount. As a result the current flow through *R*8 and therefore the voltage drop across it falls to almost zero. In this case, too, very little positive feedback voltage is produced. At some intermediate frequency the positive feedback will be maximum.

(3) *Frequency of oscillation.* The frequency at which the amplitude of the positive feedback exceeds the amplitude of the negative feedback and therefore produces oscillations is:

$$f_o = \frac{1}{2\pi(R2)\cdot(C2A)}$$

b. Phase Relations. In addition to changing the amplitude of the positive feedback, capacitors *C*2*A* and *C*2*B* also vary its phase. The amount of phase change between the output voltage, E_o, and the voltage fed back to the grid, E_f, varies with the frequency.

(1) *At very high frequencies.* At very high frequencies, the series combination of *R*2 and *C*2*A* can be represented effectively by a resistance, because of the very small reactance of *C*2*A*. The very small reactance of *C*2*B*, however, causes the parallel combination of *C*2*B* and *R*8 to act essentially as a capacitor; the smallest impedance in a parallel combination draws the most current. Under these circumstances, the voltage divider (*R*2, *C*2*A* and *R*8 and *C*2*B*) and its associated vector diagram can be represented as in A of figure 9. The current through the circuit is taken as a reference point. Since the voltage across the resistor, E_R, is in phase with the current flowing through it and the voltage across the capacitor, E_C, lags the current through it by 90°, these two vectors are drawn as shown. E_o, the output voltage, is obtained by adding E_R and E_C vectorially. From the vector diagram it is obvious that the feedback voltage, E_f, which is equal to E_C, *lags* the output voltage, E_o by θ_1°.

(2) *At very low frequencies.* At extremely low frequencies, both capacitors have very high reactance. Therefore, the impedance of *C*2*A* overshadows the

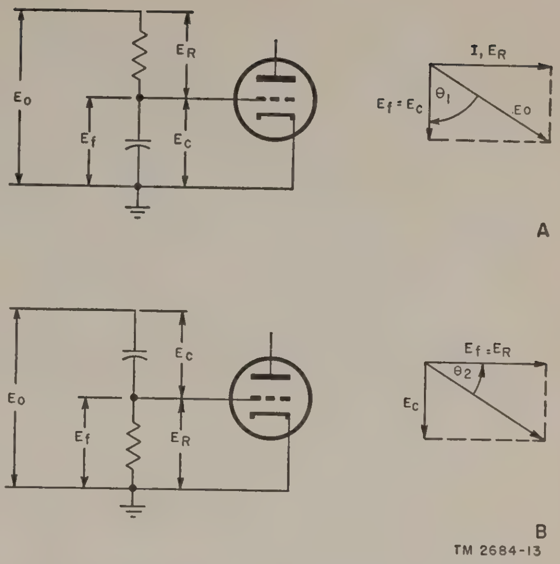


Figure 9. Phase relations in feedback circuit of Wien-bridge oscillator.

impedance of $R2$, whereas the value of the parallel combination is essentially that of $R8$. The effective circuit and its associated vector diagram are as shown in B of figure 9. Here again, E_R is in phase with the current, E_C lags the current by 90°, and E_o is the vector sum of both. But now the feedback voltage, E_f, is not equal to E_C, but is equal to E_R. Therefore, E_f *leads* the output voltage, E_o, by $\theta_2°$.

(3) *Frequency of oscillation.* At some intermediate frequency, as determined by the formula previously given ($f_o = ½ \pi (R2) (C2A)$), the leading and lagging effects cancel each other out. Because no phase change occurs across the bridge at this frequency, oscillations are produced.

c. Components.

(1) Lamp $R11$, in the cathode of $T1$, stabilizes the amplitude of oscillation. Any increase in amplitude tends to increase the current through the lamp, making its filament hotter. The greater resistance of the hotter filament increases the negative feedback, which in turn reduces the gain of the stage, thus returning the signal to its original amplitude. $R10$ is a fixed resistance having a value between 0 and 800 ohms. Because its value determines the point of stabilization, resistor $R10$ should be changed when replacing lamp $R11$.

(2) The tuning dial is connected to four capacitors which are ganged together. $C2A$ represents two of these capacitors connected in parallel, and $C2B$ represents the other two capacitors connected in parallel. $C1$ is the trimmer for $C2A$, and $C8$ is the trimmer for $C2B$.

(3) RANGE switch S1 has two sections. One section determines which resistor ($R1$, $R2$, $R3$, or $R4$) is placed in series with $C2A$; the other section selects the parallel resistor ($R5$, $R6$, $R7$, or $R8$) across $C2B$.

(4) $R12$ is the plate load of tube $T1$, and $R15$ is the plate load of tube $T2$. $R30$ and $C11A$ form a decoupling circuit in the plate of tube $T1$, $C3$ is the coupling capacitor, and $R13$ is the grid resistor. Cathode bias for tube $T2$ is obtained across resistor $R14$, which is bypassed by capacitor $C10$.

(5) In both tubes, screen voltage is obtained from a voltage divider: $R24$ and $R25$ in tube $T1$, and $R26$ and $R27$ in tube $T2$. The voltage divider arrangement makes possible a stable screen voltage.

(6) To keep phase changes, other than those in the bridge, to a negligible minimum, capacitor $C4$ is made very large and most bypass capacitors are kept out of the circuit. One exception is capacitor $C14$ which is made small (250 $\mu\mu$f (micromicrofarads)) so that it will act as a screen bypass and thus increase the gain at high frequencies only.

(7) The other exception is $C9$, the bypass across lamp $R11$. This is made small (approx. 80 $\mu\mu$f) so that it will control the negative feedback at the top of the frequency range only.

34. Amplifier

(fig. 10)

The two-stage amplifier is designed to deliver 100 mw into a 1,000-ohm resistance load over a major portion of the frequency range. By using extensive feedback the internal impedance is only 50 ohms at 400 cps, and therefore the output is not critical with load. The total harmonic distortion of the amplifier is less than one-half of one percent.

a. Voltage Amplifier. $T3$ uses a type 6J7 pentode in a voltage amplifier circuit. The oscillator output is applied through blocking capacitor $C4$, output limiting resistor $R17$, and VOL. control $R16$ to the grid of tube $T3$. The signal is developed across the plate load $R19$. The plate is decoupled from the other stages by $R31$ and $C11b$. $R28$ and $R29$ form a screen voltage divider; this arrangement keeps the screen voltage stable. To reduce distortion, negative feedback is introduced within this circuit by leaving screen resistor $R28$ and cathode resistor $R18$ unbypassed.

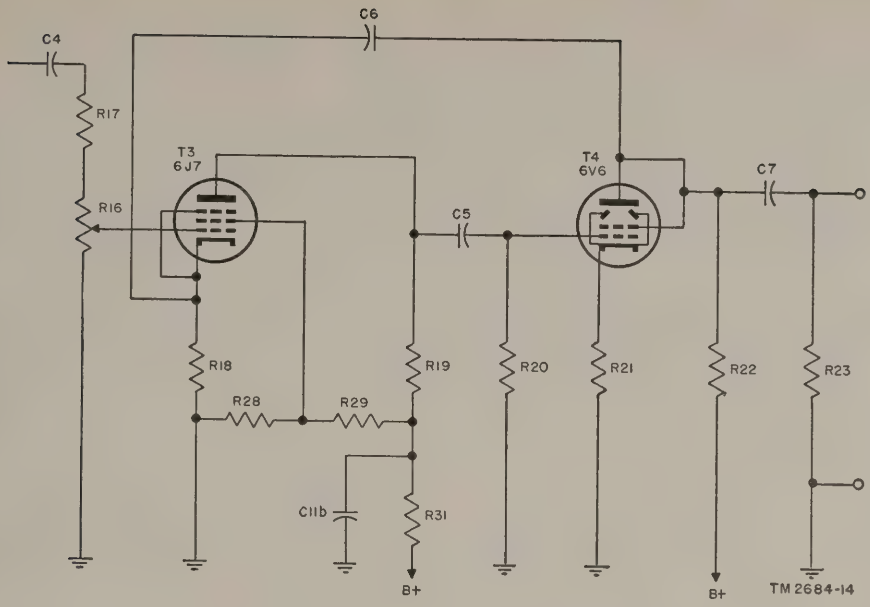


Figure 10. Audio amplifier, simplified schematic diagram.

*b. Power Amplifier. T*4 uses a type 6*V*6 beam power tube in a power amplifier circuit of great fidelity. This fidelity is obtained, partially, by operating the tube as a triode, and by leaving cathode resistor *R*21 unbypassed. *C*5 and *C*7 are blocking capacitors. *R*20 is the grid resistor, *R*22 is the plate load resistor, and *R*23 is the leakage resistor for capacitor *C*7.

c. Feedback. To broaden the frequency response and to reduce distortion, negative feedback from the output of *T*4 to the cathode of *T*3 is introduced by capacitor *C*6. To see that this is negative feedback, follow a signal through the circuit. If a positive-going signal is applied to the grid of *T*3, the 180° inversion of tubes *T*3 and *T*4 will produce a positive-going signal at the plate of *T*4. This positive-going signal when applied to the cathode of *T*3 counteracts the effect of the original positive-going signal on the grid.

35. Power Supply

(fig. 17)

B+ is obtained from a full-wave rectifier circuit using tube type 5*Y*3*GT* (*T*5), power transformer *TR*1, and a pi filter composed of capacitors *C*12 and *C*13 and choke *L*1. One winding of transformer *TR*1 secondary provides voltage for all tube filaments. A pilot lamp across this winding lights when ON-OFF switch *S*2, in the primary of *TR*1, is closed. Fuse *F*1 protects the circuit from overloads.

CHAPTER 5

FIELD MAINTENANCE INSTRUCTIONS

Note. This chapter contains information for field maintenance. The amount of repair that can be performed by units having field maintenance responsibility is limited only by the tools and test equipment available, and by the skill of the repairman.

Section I. TROUBLE SHOOTING AT FIELD MAINTENANCE LEVEL

Warning: When servicing the equipment, be extremely careful of the high voltages exposed. Discharge all filter capacitors before doing any testing. Before touching any part after the voltage is shut off, short the part to ground.

36. Trouble-shooting Procedures

The major step in servicing the equipment is to localize the fault. Localization means tracing the fault to the defective part responsible for the abnormal condition. Some faults, such as burned-out resistors and shorted transformers often can be located by sight, smell, and hearing. To locate the majority of faults, the procedures listed below should be followed. One of the best means of locating trouble is the use of the voltage and resistance diagram (fig. 11).

a. Operational Test. The operational test, using the equipment performance checklist (par. 31), is important because it frequently indicates the general location of trouble. In many instances, this information will indicate the exact nature of the fault. In order for this information to be utilized fully, all symptoms must be interpreted in relation to one another.

b. Checking Fuse F1. Fuse F1 can be checked without removing the covers by taking a resistance reading across the a-c plug with the ON-OFF switch closed; the resistance reading should be very low (fig. 17), but if fuse F1 is open the resistance reading will be infinite.

c. Visual Inspection. Through visual inspection alone (par. 29), the repairman may frequently discover the trouble, or determine the stage in which the trouble exists. This inspection is valuable in avoiding additional damage to the equipment and in forestalling future failures.

d. Using Trouble-Shooting Chart. Extensive use of this chart (par. 40) will aid materially in localizing trouble.

e. Making Voltage Measurements. Voltage measurements are an indispensable aid to the repairman, because most troubles either result from abnormal voltages or produce abnormal voltages.

(1) *Voltage and resistance measurements.* Complete information on normal operating voltages is given in figure 11. Before making voltage readings, be careful to set the controls as indicated in the notes at the bottom of the figure.

(2) *Voltmeter loading.* If the resistance of the voltmeter is not at least 10 times as large as the resistance of the circuit across which the voltage is measured, the voltmeter reading will be less than that indicated in the chart. To minimize this effect, use the highest meter range. The readings obtained will have the greatest accuracy if a 20,000-ohm-per-volt meter is used; the voltage and resistance diagram (fig. 11) is based on readings taken with a 20,000-ohm-per-volt meter.

f. Making Resistance Measurements. When a fault develops in a circuit, its effect very often will show up as a change in the resistance values. Figure 11 shows the normal resistance values as measured at the tube sockets. These values are measured between the indicated points and ground, unless otherwise stated. Before making any resistance measurements, turn off the power. If the ohmmeter is connected to a circuit that has a voltage in it, the meter may be damaged.

Caution: Always discharge h-v (high voltage) capacitors before making resistance measurements.

g. Tube Checking. Tube faults are responsible for a large percentage of failures which occur in test equipment. When putting a new tube into a circuit, it may be necessary to recalibrate the set and to test it for distortion.

h. Locating Intermittents. In all these tests, the possibility of intermittents should not be overlooked. This type of trouble may appear when the set is tapped or jarred. Look for loose connections. It is possible that the trouble is not in the set itself but in the a-c line cord or plug.

37. Trouble-shooting Data

Take advantage of the material supplied in this manual. It will help in the rapid location of faults. Consult the following trouble-shooting data:

Fig. No.	Description
5	Block diagram.
11	Voltage and resistance measurements.
12	Top view of chassis.
13	Bottom view of chassis.
15	Resistor color codes.
16	Capacitor color codes.
17	Schematic diagram.

38. Test Equipment Required for Trouble Shooting

The test equipment required for trouble shooting Audio Oscillators TS–382/U and TS–312/FSM–1 is listed below. The technical manuals associated with the test equipment are listed also.

Test equipment	Technical manual
Tube Testers I–177 and I–177–A or equal.	TM 11–2627
Multimeter TS–352/U, or equal______	TM 11–5527
Oscilloscope BC–1060–A, or equal_____	TM 11–2526
Electronic Multimeter TS–505/U____	TM 11–5511
20-mm (millimeter) flat metal gage.	
Frequency standard, the accuracy of which is as good as or better than the TS–382/U.	

39. General Precautions

Whenever the oscillator is serviced, observe the following precautions very carefully:

a. Be careful when the cover is removed; dangerous voltages are exposed.

b. Careless replacement of parts often makes new faults inevitable. Note the following points:

(1) Before a part is unsoldered, note the position of the leads. If the part, such as a transformer, has a number of connections, tag each of the leads to it.

(2) Be careful not to damage other leads by pulling or pushing them out of the way.

(3) Do not allow drops of solder to fall into the unit; they may cause short circuits.

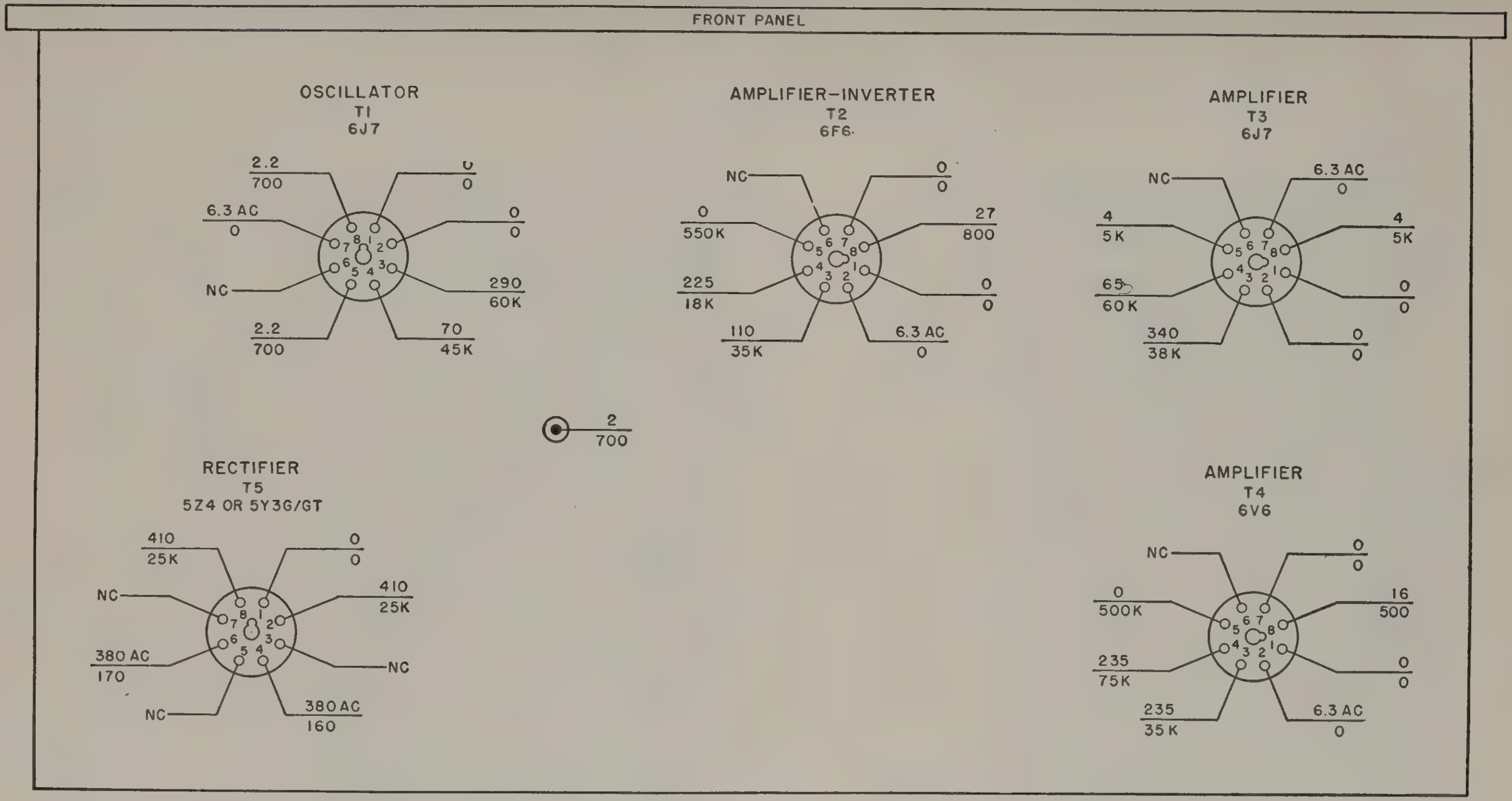
(4) A carelessly soldered connection may create a new fault. It is very important to make well-soldered joints; a poorly soldered joint is one of the most difficult faults to find.

40. Trouble-shooting Chart

The following chart is supplied as an aid in locating trouble in the oscillator. The chart lists the symptoms which the repairman observes, either visually or audibly, while making a few simple tests. The chart also indicates how to localize trouble quickly to the proper stage. Once the trouble has been localized, a tube check and voltage and resistance measurements of this stage or circuit should ordinarily be sufficient to isolate the defective part. Normal voltage and resistance measurements are given in figure 11.

Symptom	Probable trouble	Correction
1. Pilot light does not glow with ON - OFF switch ON.	1. A-c plug not properly inserted into outlet.	1. Reinsert plug.
	Defective line cord.	Repair.
	Fuse burned out.	After finding cause of opening, replace fuse.

Symptom	Probable trouble	Correction
2. 115 volts appear across TR1 primary but pilot lamp does not light.	2. Defective light.	2. Replace.
	Open transformer winding.	Replace.
3. All tubes light; pilot lamp does not light.	3. Defective light.	3. Replace.
4. All tubes light; T5 does not light.	4. Defective T5 filament.	4. Replace tube.
	Defective 5-volt secondary of TR1.	Replace TR1.
5. One or more of tubes T1 thru T4, but not all, do not light.	5. Defective T1, T2, T3, or T4.	5. Replace.
6. All tubes light, but no output.	6. Defective component.	6. Make voltage and resistance check and replace defective component.
	Shorted C1, C2, or C8.	Clean variable capacitors. Bend plates; if necessary, check calibration.
7. VOL. control has no effect on output amplitude.	7. Defective VOL. control.	7. Replace.
8. No output on one of ranges.	8. Defective RANGE switch.	8. Check wiring and repair.
	Defective resistor R1 through R8, depending upon band.	Adjust resistance.
9. Output on one range much more or much less than that on other ranges.	9. Needs calibration.	9. See paragraphs 43–47.
10. Fluctuation in amplitude of output (observable on oscilloscope or vtvm).	10. Aging of oscillator tubes or defective lamp R11.	10. Replace oscillator tubes and R11. If fluctuation does not cease, replace R10 by a resistor with a value between 0 and 800 ohms.
11. Oscillator does not oscillate over one portion of tuning dial on all ranges.	11. Shorted C2.	11. Clean C2. Bend plates if necessary. Check calibration.
12. Incorrect frequency calibration.	12. See section III of this chapter.	12. See section III of this chapter.
13. Reduced output.	13. Defective component in T3 or T4.	13. Make voltage and resistance check and replace defective components.
	Defective tube.	Replace.
14. Distorted output.	14. Defective component.	14. Make voltage and resistance checks and replace faulty component.
	Defective tube.	Replace.
15. All filaments lit, but no B+ across C13.	15. Defective T5.	15. Replace.
	Shorted C12 or C13.	Replace.
	Open L1.	Replace.
16. No voltage at plate of T1, T2, T3, or T4.	16. Open plate load R12, R15, R19 or R22, respectively.	16. Test resistors; replace if necessary.
	Open decoupling resistor R30 (in T1) or R31 (in T3).	Test resistors; replace if necessary.
17. No voltage at screen of T1, T2, or T3.	17. Defective R25, R27 or R29.	17. Test; replace if necessary.
	Shorted C14.	Test; replace if necessary.
18. Improper plate voltage on T2, T3, or T4.	18. Defective R14, R18, or R21.	18. Test; replace if necessary.
	Shorted C10, C3, C4, or C5.	Test; replace if necessary.
19. Improper plate voltage on T1.	19. Defective R1 through R8; C1, C2, or C8; R9, R10, or R11; or C9.	19. Test; replace if necessary.
20. Improper screen voltage for T1, T2, or T3.	20. Defective R24, R26, or R28.	20. Test; replace if necessary.



NOTES:

1. VOLTAGES MEASURED FROM SOCKET PIN TO CHASSIS WITH 20,000 OHMS-PER-VOLT METER.
2. RESISTANCE MEASURED FROM SOCKET PIN TO CHASSIS
3. FREQUENCY DIAL SET TO 100.
4. VOL CONTROL SET TO 100.
5. RANGE SWITCH SET TO X10.
6. VOLTAGE READINGS ABOVE THE LINE, RESISTANCE READINGS BELOW THE LINE.

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Figure 11. Audio Oscillators TS-382/U and TS-312/FSM-1, tube socket voltage and resistance diagram.

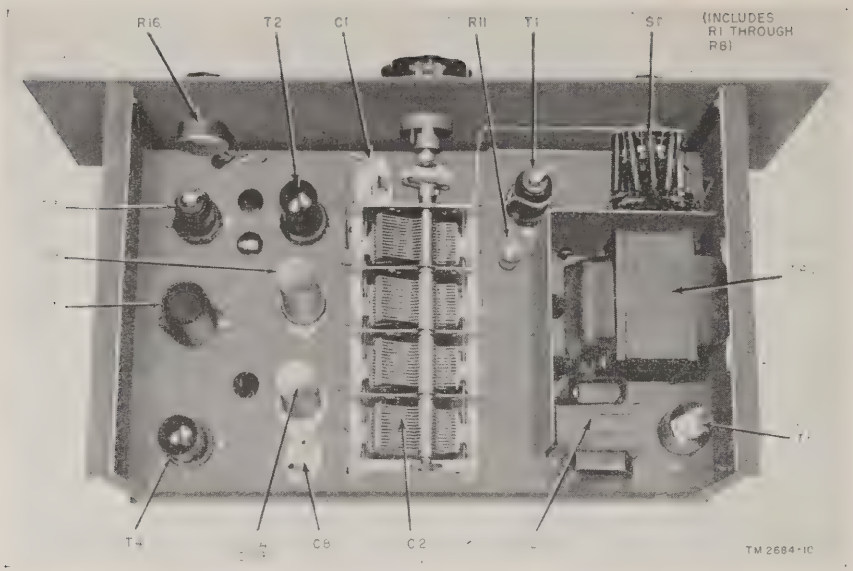

Figure 12. Audio Oscillators TS–382/U and TS–312/FSM–1, top view of chassis.

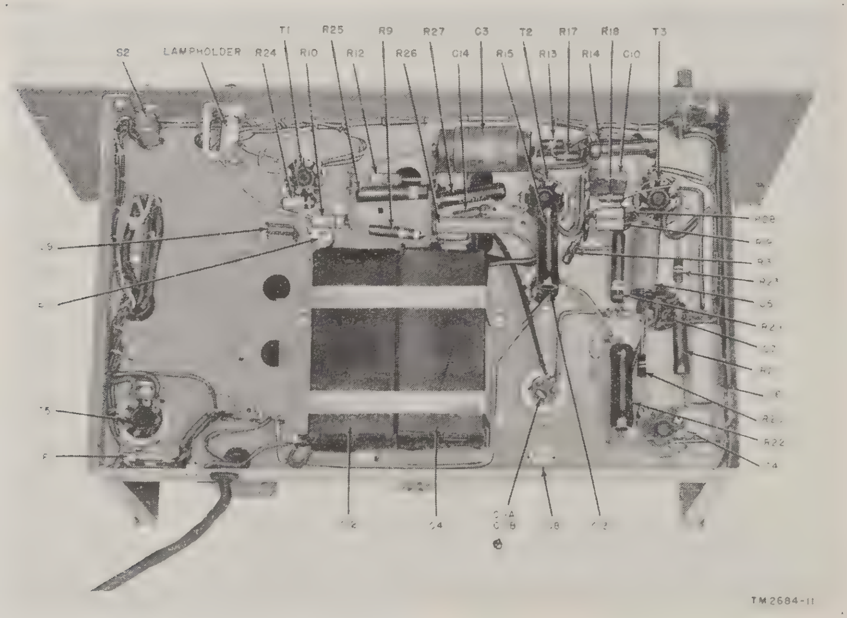

Figure 13. Audio Oscillators TS–382/U and TS–312/FSM–1, bottom view of chassis.

41. Replacement of Parts

Most of the parts in the oscillator are readily accessible and can be easily replaced. If the power transformer or RANGE switch requires replacement, mark the wires connected to them carefully with tags or other devices to avoid misconnection when the new component is installed. Follow this practice whenever replacement requires the disconnection of numerous wires.

42. Refinishing

Instructions for refinishing badly marred panels on exterior cabinets are given in TM 9–2851.

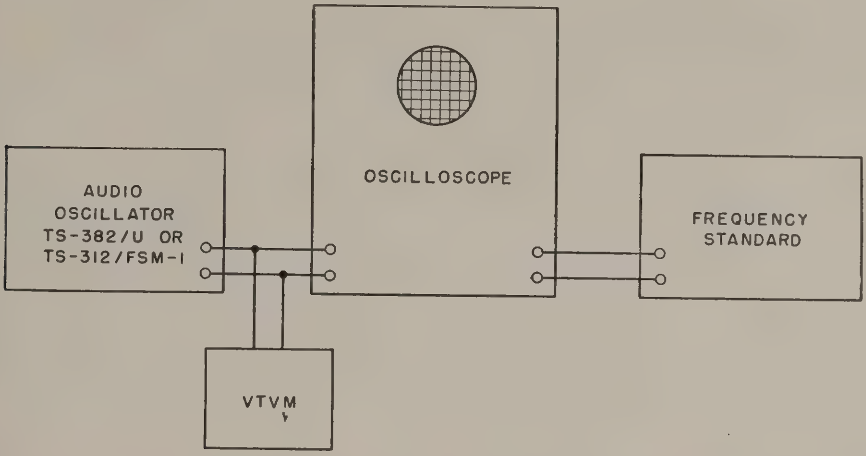

Figure 14. Equipment set-up for calibration of Audio Oscillators TS–382/U and TS–312/FSM–1.

Section III. CALIBRATION

Note. The following adjustments must be made with a line voltage of 115 volts. Calibration should be checked at least once every 3 months, because the oscillator frequency will drift, due to the aging of frequency determining resistors.

43. Calibrating Frequency Dial

a. Remove top cover.

b. Place a flat 20 mm (millimeter) metal gage on the stator of the tuning capacitor, C2.

c. Turn the tuning capacitor to the high-frequency end (plates completely unmeshed) until the rotor seats gently against the 20-mm gage.

d. The frequency indicator hairline should be directly over the last long line on the frequency dial after the 200 mark.

e. To turn the dial to the correct point without moving the variable capacitor, loosen either collar on the flexible coupling (fig. 12) by means of an Allen wrench. Hold the capacitor plates tight while turning the tuning dial. After making the adjustment, tighten the collar.

f. Replace top cover.

44. Calibrating X10 Range

a. Connect the oscillator output to the horizontal plates and connect the frequency standard output to the vertical plates of the oscilloscope. Place a vtvm across the oscillator output. The entire set-up is shown in figure 14.

b. Turn on the oscillator; set the RANGE switch to *X*10, and set the VOL. control to 20. Allow 20 minutes for the oscillator to warm up.

c. Tune oscillator to 200 cps (20 on dial). Note vtvm reading.

d. Tune oscillator to 2,000 cps (200 on dial). Again note vtvm reading. If it is not the same as the previous reading, remove the bottom cover and adjust capacitor *C*8 (fig. 13).

e. Tune the frequency standard to 2,000 cps. A stationary straight line, circle, or ellipse should be seen on the scope. Vary capacitor *C*1 (fig. 12) until this condition is obtained.

f. Repeat *d* and *e* above. This is necessary because the settings of *C*1 and *C*8 are interdependent.

g. Move the oscillator tuning dial slowly toward the low-frequency end. At the same time, check the calibration at various points.

h. As the calibration begins to be out of limits (±2 percent), remove the top cover of the oscillator and bend slightly each of the outside rotor plates of the four sections of capacitor *C*2. Do not bend the whole plate. Make the bend at the point which would be slightly in mesh when the dial line to be corrected is under the indicator hairline. Compressing the rotor plates lowers the oscillator frequencies; expanding them raises the oscillator frequency. Be very careful with this operation; the capacitor may be ruined.

i. Replace the top cover and recheck calibration.

Note. Final calibration will be correct only when adjustments are made with the top cover on the oscillator.

j. If calibration cannot be accomplished by bending the split rotor plates, change the values of range resistors R2 and R6. Repeat *c* through *g* above.

45. Calibrating X1 Range

If necessary, adjust the values of range resistors R1 and R5 for a frequency output of 100 cps at a dial setting of 100 with the RANGE switch set to *X*1.

46. Calibrating X100 Range

If necessary, adjust the values of range resistors *R*3 and *R*7 for a frequency output of 2,000 cps at a dial setting of 20 with the RANGE switch set to *X*100.

47. Calibrating X1000 Range

a. If necessary, adjust the values of range resistors R4 and R8 for a frequency output of 20,000 cps at a dial setting of 20 with the RANGE switch set to X1000.

b. Adjust capacitor C9 for a frequency output of 200,000 cps at a dial setting of 200 with the range switch set to X1000. C9 should never exceed 130 μμf.

Section IV. FINAL TESTING

48. General

This section is intended as a guide in determining the quality of a repaired audio oscillator. The tests outlined in paragraphs 50 and 51 may be performed by maintenance personnel having adequate test equipment and the necessary skills. Repaired equipment meeting the requirements given in these paragraphs will furnish uniformly satisfactory operation.

49. Test Equipment Required for Final Testing

In addition to the test equipment listed in paragraph 38, elimination filters or a commercial distortion analyzer are required for final testing of the equipment.

50. Checking Calibration

Check the calibration at the following points:

X1	100 cps
X10	200, 500, 1,000, 1,500 and 2,000 cps
X100	2,000 cps
X1000	20,000 cps and 200,000 cps

If the dial frequency is not accurate to within at least 2 percent, calibrate the set in accordance with the directions given in paragraphs 43 through 47.

51. Measuring Distortion

a. It is possible for a tube to cause excessive distortion of the output voltage without seeming to affect the operation of the oscillator. Therefore it is desirable to measure the distortion whenever tube *T*1 is changed. The measured distortion should not be greater than 2 percent for frequencies between 20 and 150 cps, and no greater than 1 percent for frequencies between 150 and 200,000 cps.

b. Sound Analyzer TS–615A/U is a harmonic wave analyzer which can be used to make an analysis of the harmonic content or distortion of the oscillator output voltage. Instructions for using Sound Analyzer TS–615A/U are contained in TM 11–5032.

CHAPTER 6

SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

Section I. SHIPMENT AND LIMITED STORAGE

52. Repacking for Shipment or Limited Storage

The exact procedure in repacking for shipment or limited storage depends on the material available and the conditions under which the equipment is to be shipped or stored. Reverse the instructions given in paragraph 8.

53. Protective Packaging

Whenever practicable, place a dehydrating agent such as silica gel inside the waterproof barrier. Protect the equipment with a waterproof paper barrier. Seal the seams of the paper barrier with waterproof sealing compound or tape. Pack the protected box in a padded wooden case, providing at least 3 inches of excelsior padding or some similar material between the paper barrier and the packing case.

Section II. DEMOLITION OF MATÉRIEL TO PREVENT ENEMY USE

54. General

Follow the demolition procedures outlined in paragraph 55 to prevent the enemy from using or salvaging this equipment. Demolition of the equipment will be accomplished only upon order of the commander.

55. Methods of Destruction

a. Smash. Smash the controls, tubes, switches, capacitors, and transformers, using sledges, axes, handaxes, pickaxes, hammers, crowbars, or heavy tools.

b. Cut. Cut cords and wiring, using axes, handaxes, or machetes.

c. Burn. Burn cords, resistors, capacitors, wiring, and technical manuals, using gasoline, kerosene, oil, flame throwers, or incendiary grenades.

d. Bend. Bend panels, cabinet, and chassis.

e. Explosives. If explosives are necessary, use firearms, grenades, or TNT.

f. Disposal. Bury or scatter the destroyed parts in slit trenches, foxholes, or other holes, or throw them into streams.

g. Destroy Everything.

APPENDIX I

REFERENCES

Note. For availability of items listed, check SR 310-20-3 and SR 310-20-4. Check Department of the Army Supply Catalog SIG 1 for Signal Corps supply catalogs.

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1. Army Regulations

AR 380–5	Safeguarding Military Information.
AR 750–5	Maintenance of Supplies and Equipment. (Maintenance Responsibilities and Shop Operation.)

2. Supply Publications

SB 11–6	Dry Battery Supply Data.
SB 11–47	Preparation and Submission of Requisitions for Signal Corps Supplies.
SB 11–76	Signal Corps Kit and Materials for Moisture- and Fungi-Resistant Treatment.

3. Publications on Auxiliary Equipment and Test Equipment

TM 11–300	Frequency Meter Sets SCR–211–(*).
TM 11–303	Test Sets I–56–C, I–56–D, I–56–H, and I–56–J.
TM 11–307	Signal Generators I–72–G, H, J, K, and L.
TM 11–321	Test Set I–56–E.
TM 11–472	Repair and Calibration of Electrical Measuring Instruments.
TM 11–2524	Oscillators I–151–A and I–151–E.
TM 11–2526	Oscilloscope BC–1060–A.
TM 11–2613	Voltohmmeter I–166.
TM 11–2626	Test Units I–176, I–176–A, and I–176–B.
TM 11–2627	Tube Testers I–177 and I–177–A.
TM 11–5032	Sound Analyzer TS–615A/U.
TM 11–5511	Electronic Multimeter TS–505/U.
TM 11–5527	Multimeter TS–352/U.

4. Painting, Preserving, and Lubrication

TB SIG 13	Moistureproofing and Fungiproofing Signal Corps Equipment.
TB SIG 69	Lubrication of Ground Signal Equipment.
TM 9–2851	Painting Instructions for Field Use.

5. Camouflage

FM 5–20	Camouflage, Basic Principles.

6. Decontamination

TM 3–220	Decontamination.

7. Demolition

FM 5–25	Explosives and Demolitions.

8. Other Publications

FM 24–18	Field Radio Techniques.
FM 72–20	Jungle Warfare.

SR 310–20–3	Index of Training Publications (Field Manuals, Training Circulars, Firing Tables and Charts, Army Training Programs, Mobilization Training Programs, Army Training Tests, Graphic Training Aids, Joint Army-Navy-Air Force Publications, Combined Communications Board Publications and Army Communications Publications).
SR 310–20–4	Index of Technical Manuals, Technical Regulations, Technical Bulletins, Supply Bulletins, Lubrication Orders, Modification Work Orders, Tables of Organization and Equipment, Reduction Tables, Tables of Allowances, Tables of Organization, and Tables of Equipment.
SR 700–45–5	Unsatisfactory Equipment Report (Reports Control Symbol CSGLD–247).
SR 745–45–5 AFR 71–4	Report of Damaged or Improper Shipment (Reports Control Symbols CSGLD–66 (Army) and AF–MC–U2 (Air Force)).
TB SIG 25	Preventive Maintenance of Power Cords.
TB SIG 66	Winter Maintenance of Signal Equipment.
TB SIG 72	Tropical Maintenance of Ground Signal Equipment.
TB SIG 75	Desert Maintenance of Ground Signal Equipment.
TB SIG 123	Preventive Maintenance Practices for Ground Signal Equipment.
TB SIG 178	Preventive Maintenance Guide for Radio Communication Equipment.
TB SIG 219	Operation of Signal Equipment at Low Temperatures.
TB SIG 223	Field Expedients for Wire and Radio.
TM 11–453	Shop Work.
TM 11–455	Radio Fundamentals.
TM 11–466	Radar Electronic Fundamentals.
TM 11–483	Suppression of Radio Noises.
TM 11–486	Electrical Communication Systems Engineering.
TM 11–681	Electrical Fundamentals (Alternating Current).
TM 11–660	Introduction to Electronics.
TM 11–661	Electrical Fundamentals (Direct Current).
TM 11–4000	Trouble Shooting and Repair of Radio Equipment.
TM 11–5032	Sound Analyzer TS–615A/U.

9. Abbreviations

a-c	alternating-current
cps	cycles per second
db	decibel
d-c	direct-current
ma	milliampere
mm	millimeter
mw	milliwatt
r-f	radio-frequency
$\mu\mu$f	micromicrofarad
vtvm	vacuum-tube voltmeter

APPENDIX II

IDENTIFICATION TABLE OF PARTS

1. Requisitioning Parts

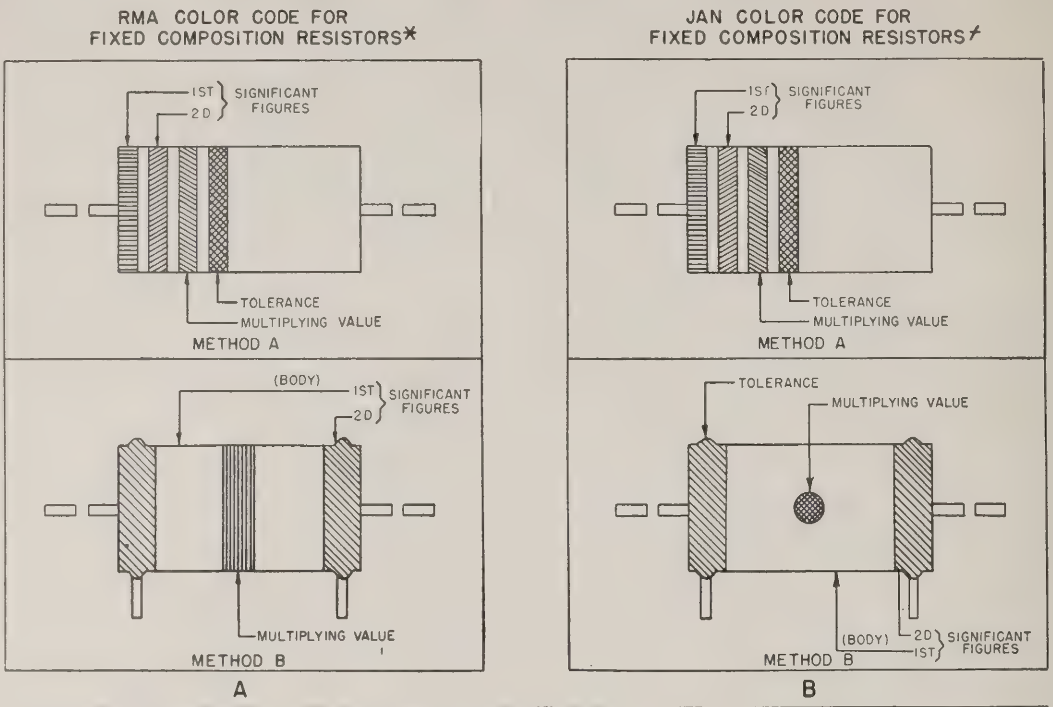
The fact that a part is listed in this table is not sufficient basis for requisitioning the item. Requisitions must cite a specific T/O&E, T/A, SIG 7&8, list of allowances of expendable material, or another authorized supply basis. The Department of the Army Supply Catalogs applicable to the equipments covered in this manual are SIG 8 TS–312/FSM–1 and SIG 7&8 TS–382/U. For an index of available supply catalogs in the Signal portion of the Department of the Army Supply Catalog, see the latest issue of SIG 1.

2. Identification Table of Parts for Audio Oscillators TS–382/U and TS–312/FSM–1

Ref symbol	Name of part and description	Function of part	Signal Corps stock No.
	CABLE ASSEMBLY, power: AC; 6 ft; w/soft rubber plug.	Connects to a-c power source	1B3018–2.28
C4	CAPACITOR, fixed: paper; 2 sect, 4–4 μf; 600 vdcw.	Keeps d-c out of oscillator feedback path and grid of T3.	3DB4–245
C6	CAPACITOR, fixed: electrolytic; 12 μf +100% —10%; 450 vdcw.	Feedback capacitor between T4 and T3.	3DB12–16
C7	CAPACITOR, fixed: electrolytic; 20 μf; 450 vdcw.	Keeps d-c off output terminal	3DB20–8
C11A, C11B	CAPACITOR, fixed: electrolytic; 2 sect, 20–20 μf; 450 vdcw.	Decoupling capacitors	3DB20–41
C13	CAPACITOR, fixed: electrolytic; 40 μf; 450 vdcw.	Power supply filter capacitor	3DB40–12
C14	CAPACITOR, fixed: mica; 270 μμf ±10%; 500 vdcw; CM20B271K.	High-frequency compensation capacitor.	3K2027121
C10	CAPACITOR, fixed: mica; 2000 μμf ±5%; 500 vdcw; CM30E202J.	High-frequency compensation capacitor.	3K70200222
C5	CAPACITOR, fixed: paper; 100,000 μμf +20% —10%; 600 vdcw.	Blocks d-c from T4 grid	3DA100–730
C3	CAPACITOR, fixed: paper; 500,000 μμf ±20%; 600 vdcw.	Blocks d-c from T2 grid	3A500–583
C12	CAPACITOR, fixed: paper; 4 μf +40% —10%; 800 vdcw.	Power supply filter capacitor	3DB4–111
C9	CAPACITOR, fixed: 80 μμf, 600 vdcw, molded mica.	High-frequency compensation capacitor.	
C8	CAPACITOR, variable: air; 25 μμf	Calibration trimmer capacitor; varies output voltage.	3D92023V–8
C1	CAPACITOR, variable: air; 6 to 100 μμf; .020 air gap.	Calibration trimmer capacitor; varies output frequency.	3D9099V–6
C2	CAPACITOR, variable: air; 4 sect, 525 μμf	Main tuning capacitor	3D9525V–3
L1	COIL, AF: radio; filter; 15 hy, 80 ma, 138 ohms.	Power supply filter choke	3Z316–67
	COUPLING, flexible drive: 1⅜" dia metal bushing for ¼" shaft; insulated.	Connect frequency dial shaft to shaft of tuning capacitor.	2Z3291–2
F1	FUSE FU–26: lamp, 250 v; Littelfuse type 3AG, #1040.	Overload protection	3Z1926

Ref symbol	Name of part and description	Function of part	Signal Corps stock No.
	FUSEHOLDER: for 3AG fuse 1⅝″ x ½″ x 3/16″ x 2⅛″ lg o/a.	Holds fuse	3Z3282–6
	KNOB: rd; bakelite; 1⅜″ flange w/engraved white line; 1⅛″ x ⅞″ d o/a.	Allows manipulation of RANGE switch and VOL. control.	2Z5843.25
	LAMP LM–52: 6–8 v, .15 amp; miniature bayonet base.	Pilot lamp	2Z5952
R11	LAMP: 3 w, 120 v; candelabra screw base	Automatic amplitude control of oscillator output.	6Z6820–3
	LAMPHOLDER: miniature bayonet base w/red jewel.	For holding pilot lamp	2Z5883–112
	POST, binding: screw type; 1⅛″ lg x ⅜″ d o/a.	Output terminals	3Z741
R18	RESISTOR, fixed: carbon; 4700 ohms ±10%; 1 w; RC30BF472K.	T3 cathode bias resistor	3RC30BF472K
R12, R19	RESISTOR, fixed: carbon; 56,000 ohms ±10%; 1 w; RC30BF563K.	R12: T1 plate load R19: T3 plate load.	3RC30BF563K
R24, R28	RESISTOR, fixed: carbon; 47,000 ohms ±10%; 1 w.	R24: T1 screen bleeder R28: T3 screen bleeder.	3RC30BF473K
R13, R20	RESISTOR, fixed: carbon; 560,000 ohms ±10%; 1 w; RC30BF564K.	R13: T2 grid resistor R20: T4 grid resistor.	3RC30BF564K
R9	RESISTOR, fixed: carbon; 3000 ohms ±5%; 1 w; RC30BE302J.	Oscillator negative feed-back control.	3RC30BE302J
R17, R23, R30, R31	RESISTOR, fixed: carbon; 10,000 ohms ±10%; 1 w; RC30BF103K.	R17: Voltage limiting resistor R23: Leakage resistor for C7. R30: T1 plate decoupling. R31: T3 plate decoupling.	3RC30BF103K
R21	RESISTOR, fixed: WW; 500 ohms ±5%; 10 w.	T4 cathode bias resistor	3RW22549
R14	RESISTOR, fixed: WW; 820 ohms ±10%; 2 w.	T2 cathode bias resistor	3RC42BF821K
R22	RESISTOR, fixed: WW; 5000 ohms ±5%; 10 w.	T4 plate load resistor	3RW28542
R10	RESISTOR, fixed: may be between 0 and 800 ohms ±10%; 1 w.	Padder resistor for R9	
R26	RESISTOR, fixed: carbon; 27,000 ohms ±10%; 3 w.	T2 screen bleeder	3Z6625–57
R15, R27	RESISTOR, fixed: WW; 10,000 ohms ±5%; 10 w.	R15: T2 plate load R27: T2 screen dropping.	3Z6610–108
R16	RESISTOR, variable: WW; 25,000 ohms ±10%; 1 w.	Volume control	3Z7425–6
R25, R29	RESISTOR, fixed: carbon; 100,000 ohms ±10%; 2 w; RC42BE104K.	R25: T1 screen dropping R29: T3 screen dropping.	3RC42BE104K
	SOCKET, tube: octal	Holds tube	3Z8650.5
S2	SWITCH SW–31: toggle; SPST; 3 amp, 250 v.	ON-OFF switch	3Z8131
S1, R1 thru R8	SWITCH AND RESISTOR ASSEMBLY: inc 2 pol, 5 pos switch; 2 ea 8.24 meg, 834,000 ohms, 82,400 ohms, 8.240 ohms; all resistors +0% —4%.	Frequency RANGE selector switch and frequency determining resistors.	3Z9903A–22
TR1	TRANSFORMER, power: pri 115 v, sec #1 350–O–350, 120 ma; sec #2 5 v, 4 amp; sec #3 6.3 v, 4.7 amp, CT.	Power transformer	2Z9613.394
T2	TUBE, electron: JAN–6F6	Amplifier inverter	2J6F6
T1, T3	TUBE, electron: JAN–6J7	T1: Oscillator tube T3: Voltage amplifier.	2J6J7
T4	TUBE, electron: JAN–6V6	Power amplifier	2J6V6
T5	TUBE, electron: JAN–5Y3G/GT	Rectifier	2J5Y3G/GT

RESISTOR COLOR CODES



COLOR	SIGNIFICANT FIGURE	MULTIPLYING VALUE	TOLERANCE (%)
BLACK	0	1	± -
BROWN	1	10	± 1
RED	2	100	± 2
ORANGE	3	1,000	± 3
YELLOW	4	10,000	± 4
GREEN	5	100,000	± 5
BLUE	6	1,000,000	± 6
VIOLET	7	10,000,000	± 7
GRAY	8	100,000,000	± 8
WHITE	9	1,000,000,000	± 9
GOLD	—	0.1	± 5
SILVER	—	0.01	± 10
NO COLOR	—	—	± 20

NOTES

* INSULATED FIXED COMPOSITION RESISTORS WITH AXIAL LEADS ARE DESIGNATED BY A NATURAL TAN BACKGROUND COLOR. NON-INSULATED FIXED COMPOSITION RESISTORS WITH AXIAL LEADS ARE DESIGNATED BY A BLACK BACKGROUND.

† RESISTORS WITH AXIAL LEADS ARE INSULATED. RESISTORS WITH RADIAL LEADS ARE NON-INSULATED.

RMA: RADIO MANUFACTURERS ASSOCIATION

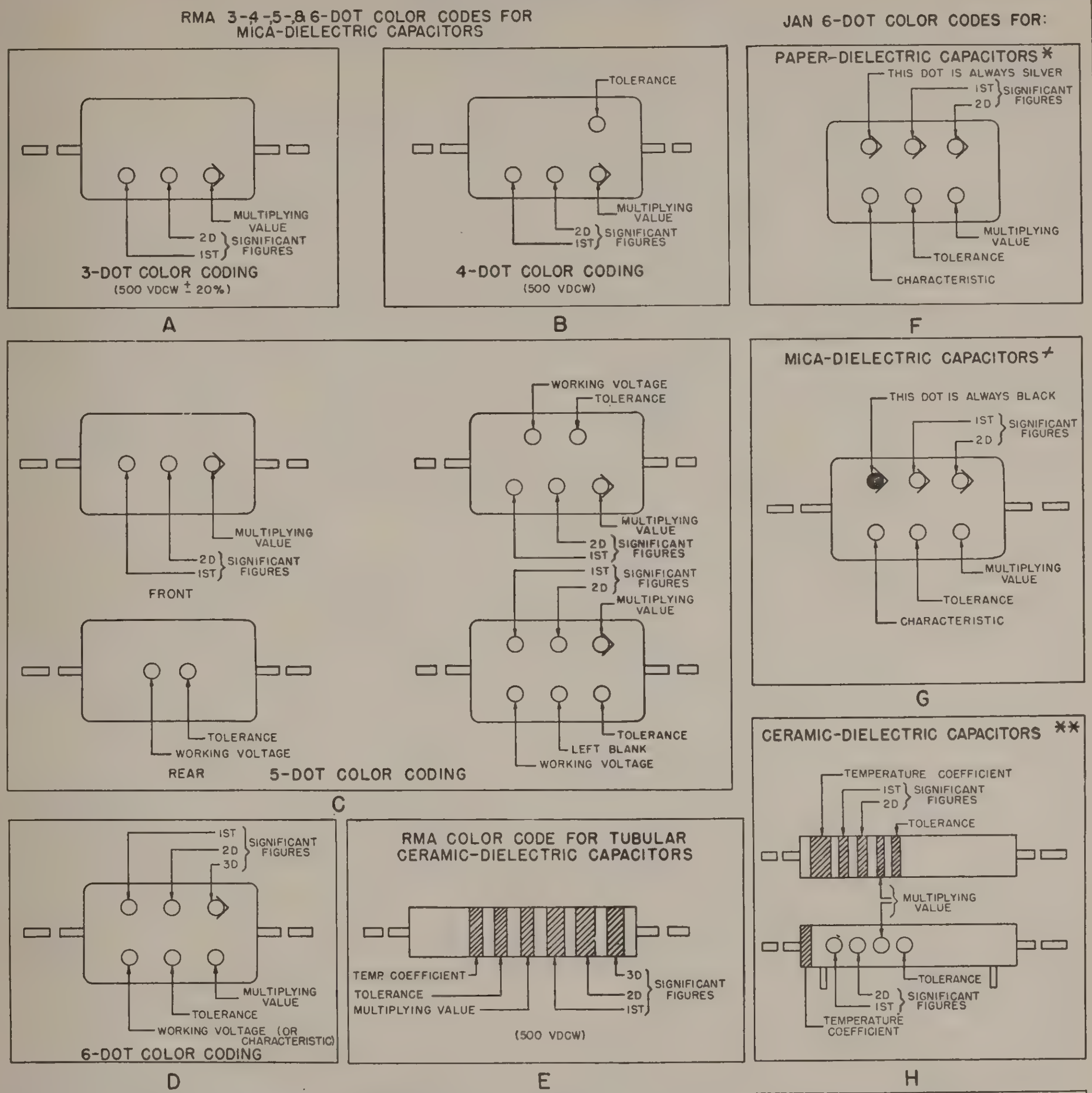
JAN: JOINT ARMY-NAVY

THESE COLOR CODES GIVE ALL RESISTANCE VALUES IN OHMS

TL32454S

Figure 15. Resistor color codes.

CAPACITOR COLOR CODES



COLOR	SIGNIFICANT FIGURE	MULTIPLYING VALUE			RMA VOLTAGE RATING
		RMA MICA-AND CERAMIC-DIELECTRIC	JAN MICA-AND PAPER-DIELECTRIC	JAN CERAMIC-DIELECTRIC	
BLACK	0	1	1	1	–
BROWN	1	10	10	10	100
RED	2	100	100	100	200
ORANGE	3	1,000	1,000	1,000	300
YELLOW	4	10,000	10,000		400
GREEN	5	100,000			500
BLUE	6	1,000,000			600
VIOLET	7	10,000,000			700
GRAY	8	100,000,000		0.01	800
WHITE	9	1,000,000,000		0.1	900
GOLD	–	0.1	0.1		1,000
SILVER	–	0.01	0.01		2,000
NO COLOR	–				500

NOTES

* THE SILVER DOT IDENTIFIES THIS MARKING FOR WORKING VOLTAGES SEE JAN TYPE DESIGNATION CODE.

✝ THE BLACK DOT IDENTIFIES THIS MARKING. FOR WORKING VOLTAGES SEE JAN TYPE DESIGNATION CODE.

** CAPACITORS MARKED WITH THIS CODE HAVE A VOLTAGE RATING OF 500 VDCW. EITHER THE BAND OR DOT CODE MAY BE USED FOR BOTH INSULATED (AXIAL-LEAD) OR UNINSULATED (RADIAL-LEAD) CAPACITORS.

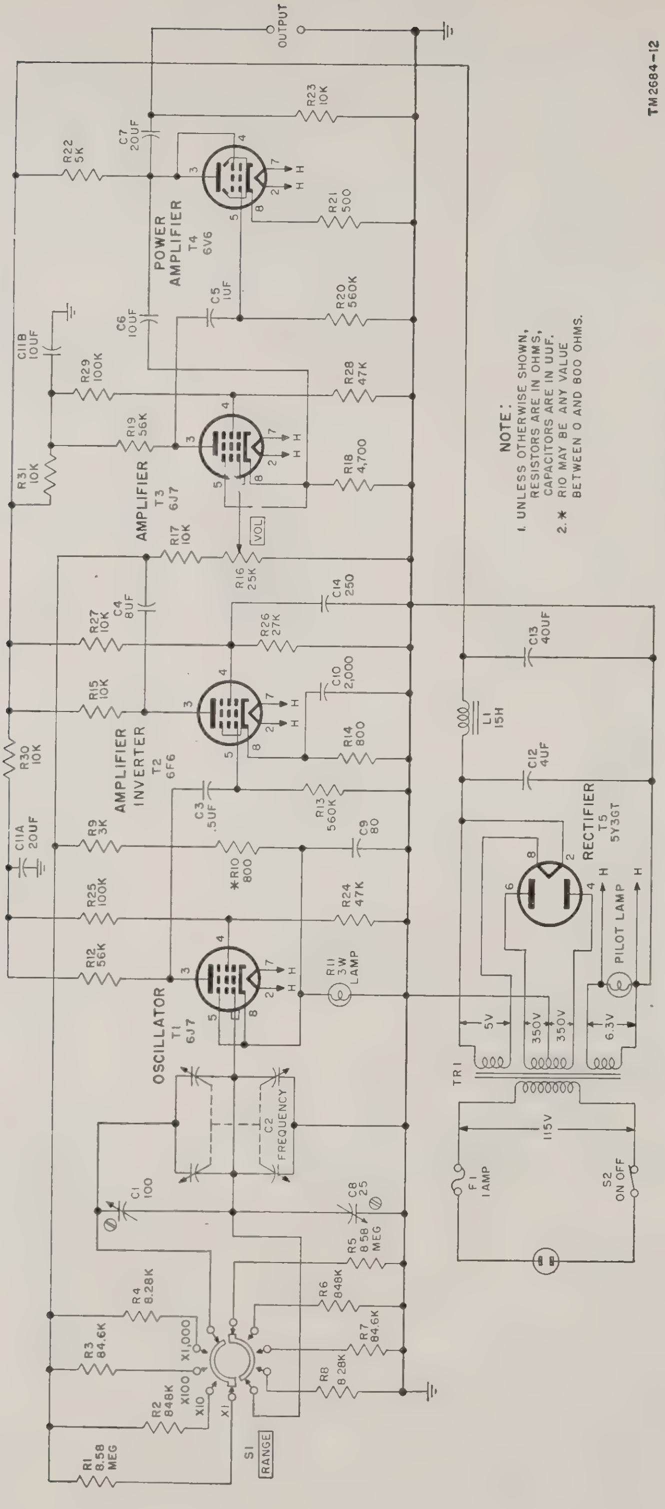
RMA RADIO MANUFACTURERS ASSOCIATION

JAN JOINT ARMY-NAVY

THESE COLOR CODES GIVE CAPACITANCES IN MICROMICROFARADS.

TL32453S

Figure 16. Capacitor color codes.



NOTE:
1. UNLESS OTHERWISE SHOWN, RESISTORS ARE IN OHMS, CAPACITORS ARE IN UUF.
2. * R10 MAY BE ANY VALUE BETWEEN 0 AND 800 OHMS.

Figure 17. Audio Oscillators TS-382/U and TS-312/FSM-1, schematic diagram.

INDEX

	Paragraphs	*Page*
Amplifier	34	16
Block diagram	32	13
Calibration:		
Frequency dial	43	23
X1 range	45	24
X10 range	44	23
X100 range	46	24
X1000 range	47	24
Characteristics, technical	4	1
Checking:		
Calibration	50	24
Fuse F1	36*b*	18
Tubes	36*g*	19
Controls	13	7
Data:		
Packaging	5	2
Trouble shooting	37	19
Demolition	54, 55	25
Description	6	2
Destruction, methods of	55	25
Diagram, block	32	13
Differences in models	7	2
Equipment:		
Installation	10	5
Performance checklist	31	11
Frequency Measuring Assembly CY–93/FSM–1.	7*b*	2
Final testing	48–51	24
Forms and records	2	1
Installation of equipment	10	5
Intermittents	36*h*	19
Lubrication and weatherproofing	25–27	10
Lubrication	25	10
Rustproofing and painting	27	10
Weatherproofing	26	10
Measuring distortion	51	24
Operation:		
Arctic climates	18	8
Desert climates	20	8
Tropical climates	19	8
Under unusual conditions	17–20	7
Under usual conditions	14–16	7
Operational test	36*a*	18
Organizational tools and equipment	21, 22	9
Packaging data	5	2
Power supply	35	17
Preliminary starting procedure	14	7
Preventive maintenance services	21–24	9
Definition	21	9
General techniques	23	9
Performing	24	9
Protective packaging	53	25
Precautions while trouble shooting	39	19
Purpose and use	3	1
Records and forms	2	1
Refinishing	42	23
Repacking for shipment and limited storage.	52	25
Repairs	41, 42	23
Replacement of parts	41	23
Scope	1	1
Service upon receipt of equipment	8–11	4
Service upon receipt of used or reconditioned equipment.	11	6
Siting	9	5
Starting procedure	15	7
Stopping procedure	16	7
Switching Panel SA–30/FSM–1	7*b*	2
Technical characteristics	4	1
Test equipment required:		
Final testing	49	24
Trouble shooting	38	19
Theory	32–35	13
Amplifier	34	16
Block diagram	32	13
Power supply	35	17
Wien-bridge oscillator	33	13
Tools and materials	22	9
Trouble shooting:		
By using equipment performance checklist.	30	11
Chart	40	19
Data	37	19
Procedures	36	18
Trouble shooting at organizational maintenance level.	28–31	11
Equipment performance checklist	31	11
Scope	28	11
Visual inspection	29	11
Trouble shooting at field maintenance level.	36–40	18
Uncrating, unpacking, and checking new equipment.	8	4
Use and purpose	3	1
Visual inspection	29, 36*c*	11, 18
Wien-bridge oscillator	33	13

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